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BOARD OF EDUCATION.

COMMITTEE ON THE COST OF SCHOOL BUILDINGS.

REPORT

AND

ABSTRACTS OF EVIDENCE

TAKEN BEFORE THE

DEPARTMENTAL COMMITTEE

ON THE

COST OF SCHOOL BUILDINGS.

Presented to both Houses of Parliament by Command of His Majesty.



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COMMITTEE ON THE COST OF SCHOOL BUILDINGS.
(BOARD OF EDUCATION.)

Constitution of Committee and Terms of Reference.

The Committee was appointed by the President of the Board of Education in February 1910, and was constituted as follows :—

Mr. L. A. SELBY-BIGGE, C.B., Principal Assistant Secretary of the Elementary Education Branch of the Board of Education (Chairman).

Mr. N. T. KERSHAW, C.B., Assistant Secretary of the Local Government Board.

Mr. F. CLAY, Architect of the Board of Education.

Mr. J. G. MILNE, Senior Examiner of the Board of Education, to act as Secretary.

The Terms of Reference to the Committee were : To inquire and report—

- (a) Whether the cost of buildings for Public Elementary Schools can properly, and with due regard to their suitability and durability, be reduced by the use of materials or methods of construction different from those ordinarily employed at present ; and, if so,
 - (b) What steps should be taken to facilitate the adoption of such materials or methods, and whether any alteration in the law is required for the purpose.
-

REPORT.

To the Right Honourable WALTER RUNCIMAN, M.P., President
of the Board of Education.

Introductory.

We have the honour to present to you the following Report of our inquiry into the possibility of reducing the cost of Public Elementary Schools by the use of materials or methods of construction different from those ordinarily employed at present.

1. We have held 16 meetings and examined 30 witnesses, summaries of whose evidence are given with this Report. These summaries have been submitted to and approved by the witnesses in every case. We have also visited buildings at Anerley, Ipswich, Bordon Camp, Harrow, Borstal, and Windsor, for the purpose of investigating novel methods of construction. We communicated with the Councils of the Royal Institute of British Architects, the Royal Sanitary Institute, the Land Agents' Society, the Surveyors' Institution, the Quantity Surveyors' Association, the Institute of Civil Engineers, the Association of Municipal Corporations, and the County Councils Association; and also with the War Office, Admiralty, and Home Office. These bodies have co-operated with us and placed at our disposal a considerable body of valuable expert opinion. In particular we desire to express our obligation to the Council of the Land Agents' Society, who appointed a special committee to collect evidence from their members, and, in addition to sending out a circular letter for this purpose, prepared a summary of the whole of the replies received. We further addressed inquiries to the Education Committees of all County Councils and County Boroughs in England and Wales, 141 in number, and received replies from 55 of these; 15 authorised their officers or architects to give evidence before us, which was duly taken, except in the case of Bradford, whose Borough Architect furnished some useful information, although the witnesses nominated were at the last moment prevented from attending; and 8 others submitted memoranda or suggestions, in some cases of considerable length and interest. In addition, we have received offers of evidence and assistance from a number of independent architects and engineers, of which we have generally availed ourselves.

2. Before dealing with the specific question referred to us and attempting to estimate the reduction in cost obtainable by the use of novel materials or methods of construction, we have

found it desirable, and indeed necessary, to consider what is the standard cost of school buildings according to the best existing practice. It is notorious that in building, as in other practical arts, the gap between the best and the worst or even the ordinary standards is very great, and the possible saving to be effected by particular devices must obviously be estimated not by reference to the standard of extravagant or even moderately costly work, but by reference to the most economical work which is done under existing conditions, or even to the most economical work which can be done without the adoption of those devices. We have, therefore, thought it relevant to our inquiry to consider not only the actual present cost of school buildings but also the causes to which that cost is attributable and the means by which, without the adoption of novel materials or methods of construction, that cost might be reduced. We shall then have something like a standard by which to judge whether and how far further reduction in cost is practicable. This is the purpose of the preliminary sections of our Report.

A.—The “Useful Life” of School Buildings.

3. So far as the cost of school buildings depends on their solidity of construction and the standard of durability which the architect adopts, it is proper in the first place to consider what is the expectation of “useful life” for which an architect should allow in designing them and how far it is possible to make their “structural” coincide with their “useful” life. It is, of course, obvious that the standards of ventilation, lighting, heating, sanitation, and general comfort have risen very greatly during the last 25 years. It is also well understood by all experts that methods of instruction, classification, and staffing have undergone a process of development which amounts to little less than a revolution, and that, generally speaking, the way in which the buildings of a good school are used, and the purposes which they serve, are altogether different from those which were in vogue not many years ago. Comparatively modern buildings have thus become old-fashioned, and it is a matter of common remark, and indeed of complaint, that buildings erected not long ago, which are still quite sound structurally, have to be extensively altered or completely remodelled, in order to adapt them to the organisation of an up-to-date school. Although it may be expected that the changes in school organisation and in the standard of school hygiene and comfort will not be so extensive and rapid in the future as in the past, it would be rash to suppose that the process of hygienic and educational development has nearly reached its limit or that this process will not continue to modify the planning of school buildings. In designing school buildings therefore the architect cannot afford to overlook the possibility of their being remodelled or even abandoned at some

future date, which will involve some waste or sterilization of capital expenditure. He will therefore plan his buildings on the simplest possible lines, so as to facilitate alteration of the internal arrangements. He will also recognise that the degree of durability and immunity from repairs at which he may legitimately aim is limited, that it is not good practice either from an educational or from an economical point of view to make school buildings as solid or durable as warehouses or churches, and that so long as his building will be warm, weather proof, and inexpensive to maintain during the period of its useful life, he is at liberty to make some sacrifice of durability to saving in first cost.

These general observations merely state the problem, but the problem itself is one which is not unfrequently overlooked.

4. In localities where, owing to the nature of the ground, it is practically impossible to secure a stable foundation, or where (*e.g.*, by the extension of mining operations) the support of the buildings may be withdrawn, it is essential not only to reduce the weight of any building to a minimum and to modify its construction, but also to avoid any unnecessary expense in erecting it, since it may be rendered uninhabitable at a comparatively early date.

Where, moreover, the population is of a shifting or exceptional character, and it is uncertain whether any school or so large a school will be required in the locality after a limited period of, say, 15 or 20 years, something between a permanent and a temporary building is wanted. The demand for such a building arises not only in mining and other industrial districts, but also in towns where the working class population is gradually moving out to the suburbs, but where, pending the completion of the process, there is urgent need for new school buildings in the older and central districts. The ingenuity of school architects may well be directed to find a satisfactory type of semi-permanent school building which shall be cheap to erect, inexpensive to maintain, cool in summer, and warm and dry in winter. There is reason to believe that there are a good many cases in which it would be prudent for the Local Education Authority to propose and legitimate for the Board of Education to approve the erection of such buildings in which durability is treated as a matter of secondary importance.

5. The purely temporary school building is almost invariably, from an educational point of view, much superior to any permanent building designed for other purposes which is pressed into the service of education. It is, however, at best an expensive and unsatisfactory device, only justifiable in cases of emergency or to meet a sudden growth of population, and the scope for the use of it appears to be diminishing as Local Education Authorities catch up with the arrears of school supply which confronted them after 1902.

In this Report, therefore, we have considered the suitability of various methods and materials submitted to us from the

point of view of the "useful life" which may be assigned to permanent or semi-permanent school buildings.

B.—Circumstances affecting the Cost of Elementary School Buildings.

6. It is generally admitted that there has been a very material increase in the cost of erection of school buildings in recent years. Evidence on this point has been submitted to us by architects who have been continuously engaged in the work of planning schools, in some cases for nearly 40 years; and it would appear that while in the period immediately following the Elementary Education Act of 1870 it was found to be possible to provide schools in most localities at a cost of 5*l.* or 6*l.* per place, the cost of a modern permanent school erected under favourable circumstances according to ordinary modern practice cannot be put much under 10*l.*, and a reasonable estimate for an ordinary building designed with due regard to economy would range from that figure up to 13*l.* 10*s.* per head, according to the provision made for halls and instruction in domestic subjects and manual work.

7. This increase of cost is due, to a very large extent, to conditions which are not under the direct control of the Local Education Authorities. We have already referred briefly to the rise in standards of comfort and hygiene, and the development of educational methods, on which the Board of Education in their Report for the year 1908-9 have laid considerable stress. We may instance a few of the ways in which this advance has most obviously involved greater expenditure. In 1870 it was regarded as sufficient if 8 square feet of floor space was provided for each child; the minimum requirement now is 10 square feet for children over about 8 years of age and 9 square feet for those under that age, while in the latter case a further provision of free space for exercises has to be made; so that the mere superficial area to be covered has been increased by practically a quarter. The earlier type of school building, which survived in some places, with or without modification, for some time after 1870, was virtually a single room, where all teachers (the average of whose qualifications was low) and classes could be under the eye of the head teacher at the same time: it is now regarded as a matter of the first importance that every class should be taught in effective separation from its neighbours, and consequently the interior of the school must be subdivided into classrooms, and the provision of a classroom for every class has become the rule in all new schools. Since the introduction of the classroom system, there has been a progressive movement in favour of a reduction in the size of classes, which involves still further subdivision of the building and multiplication of the areas of floor space not occupied by desks but required for the teacher,

the blackboard, &c. At the same time, while classes have been segregated into separate rooms for teaching purposes, it has been found highly desirable to have a large room where all the scholars or several combined classes may be assembled; and so, when the single schoolroom disappeared in favour of classrooms, additional provision had to be made in the shape of a "hall," the need for which has been more and more felt as the importance of physical training and exercises has been realised. Amongst more recent developments we may notice the wider recognition which is now given to the value of domestic and manual training, subjects for which is required a certain amount of extra space and equipment beyond that sufficient for the purposes of the old elementary curriculum.

8. To these educational improvements, and the extra expense they involve, no exception has been taken, except in a few unimportant details, by the witnesses who appeared before us. In general, Local Education Authorities and their architects have kept well in advance of the minimum requirements of the Board of Education, and the arrangements necessary in order to meet the stricter requirements of the present standard of school hygiene have been even more readily adopted. The provision for heating, ventilation, and lighting of schools is in many cases almost double that which was regarded as sufficient thirty years ago; but every witness who has touched on these points has deprecated strongly any attempt to reduce capital expenditure by cutting down or omitting items which tend to secure more healthy conditions for the children under instruction. In several cases we have found that the witnesses were reluctant even to discuss the possibility of dispensing with items which they regarded as advantageous, although they were not required by the Board of Education.

9. A cause of increase in cost which is clearly beyond the control of the Local Education Authorities lies in the general rise of building prices. We have not thought it necessary to collect evidence on this point, as there are published statistics which are readily available for reference. To a large extent this increase is due to a permanent rise in the cost of labour, but in other respects the cost of building is liable to fluctuation; at the present time there are slackness and severe competition in the building trade which have materially reduced the cost of school buildings.

10. It must be admitted, however, that Local Education Authorities do not all or always practise in fact those reasonable economies which are really in their own power, or exercise sufficient control or self-restraint in the matter of the style and general character of school buildings. The "ecclesiastical" type of school is happily disappearing. It was a most unhappy invention from every point of view and has proved lamentably expensive. It may be admitted also that the liking for florid

and pretentious elevations is less prevalent and that the general improvement of the public taste is reflected in a greater appreciation of simple, dignified, and appropriate exteriors on which decorative "trimmings" are conspicuous by their absence. It still, however, is the case that local patriotism sometimes confuses modesty and simplicity with meanness, and demands a school building which shall not only not clash with neighbouring buildings but shall form a striking feature of the district or by mere costliness enhance in popular opinion the dignity of the locality; and where district committees are allowed much influence in the selection of plans their influence is not infrequently conducive to extravagance.

11. In other cases Local Authorities or their committees are influenced by the laudable desire to have the best school building which money can buy, and submit to the Board of Education plans and specifications in which no item is conspicuously extravagant, but the highest possible standard is adopted in every respect; the result being a very spacious, durable, finely finished, and completely equipped building, costing a very large sum per scholar accommodated.

We may perhaps say here that we have received no evidence which indicates that a Local Education Authority is justified in adopting any such sum as 20*l.* per head of accommodation as the standard by which to estimate the cost of ordinary school buildings which do not contain a large number of special or supplementary rooms.

No evidence was given that the adoption of an unnecessarily high standard is encouraged, much less required, by the Board of Education; but it is obvious that they cannot refuse to pass plans on the ground that they are too good without mixed feelings and some embarrassment.

12. As will appear from the figures given below, the cost of school buildings largely depends on the number and character of the special rooms which are provided over and above the essential minimum of classrooms, cloakrooms, offices, &c.—such as "halls," rooms for instruction in Wood and Metal Work, Domestic Subjects (Cookery, Laundry, and Housewifery), Drawing, and Elementary Science, dining-rooms (for use by children who bring their own dinners or for meals provided under the Provision of Meals Act), bathrooms, medical inspection rooms, and school libraries. It is not within our functions to offer any opinion whatever as to what supplementary rooms should or should not be provided in a Public Elementary School, but it is obvious that from an economical point of view the question whether they can or will be used fully and continuously or only occasionally and spasmodically is one of the first importance. For instance, if the hall is so designed that it cannot be used for singing, physical exercises, &c., without disturbing the work of the classes in the classrooms (as is the case where classrooms

are grouped round and open directly out of the hall), it is less likely that full use of the hall will be made for its proper purposes than if it is isolated or "insulated." It is still more obviously wasteful to provide a hall for special purposes and subsequently to fill it with desks and use it as an overflow room for the ordinary work of classes. Where, however, the hall is made the chief architectural feature of a block of buildings and is built with high thick walls and an expensive roof, the relation between expenditure and educational value which everyone desires to preserve becomes still more distant. As regards rooms for Manual and Domestic Instruction, there is, we believe, a tendency in the case of large schools to provide them in or in close connection with the school buildings, but there is also a tendency (which from the financial point of view must be welcomed) to make one special room serve several special purposes and to make the ordinary rooms also serve special purposes. Generally speaking, the tendency to provide an extra room for each special branch of work is less marked than it was a few years ago, and this is particularly the case with rooms for Art and Science. In some cases the pressure on the school accommodation has led to their appropriation to the ordinary class work as overflow rooms. In other cases the school work has not in fact developed on the lines expected. So far as we are concerned, we note with satisfaction the ingenuity with which many school architects are contriving to get the utmost possible service out of school buildings, and taking every opportunity of providing facilities for special branches of school work or for improving the health and physical condition of school children without appreciably increasing the total cost of the buildings.

13. While we have no evidence that a material part of that expenditure on Elementary School buildings which has been characterised as excessive is due to the requirements of the Board of Education, it appears attributable in not a few cases to misunderstanding or disregard of the Board's Building Regulations. Except in some small and unimportant details, those regulations were considered by all the witnesses to represent a fair and reasonable standard, any lowering of which they strongly deprecated. But we have found that witnesses who had been responsible for the erection of several schools were under a misconception as to the meaning of these regulations on certain important points, such as the provision of Halls, or did not sufficiently appreciate the distinction between the "principles" laid down in Part I., which are intended to assist in the planning of schools, but not to restrict liberty of treatment, and the more precise "rules" contained in Part II. of the Regulations.

14. The evidence laid before us indicates that the most economical buildings, considered in relation to their efficiency

for educational purposes, have been provided by architects who have made a special study of school planning, either as the official architects of Local Education Authorities or in the course of private practice. Good results have been obtained both where the permanent staff of a Local Education Authority have designed schools and supervised their erection, and also where the work has been entrusted to an unofficial architect. On the other hand there are cases in which the employment of a local official whose principal duties are not those of an architect has led to results just as unsatisfactory as arise from the employment of an independent architect who has made no special study of schools. It has been urged to us by more than one witness, and we fully concur in the doctrine, that the work of designing school buildings is in fact a highly specialised branch of the architectural profession, and that real economy can only be secured by a thorough acquaintance with the actual needs of schools in practice and the constant comparison of various expedients adopted to meet these needs, both in this country and abroad. The evidence of the witnesses from Staffordshire, Derbyshire, Lancashire, and Middlesex (among others) appears to us to illustrate the advantages which may be obtained by an intelligent study on the part of local officials of the problem of securing an efficient and sanitary school building at a minimum cost.

On the other hand, so far as ordinary Elementary School Buildings are concerned, the evidence which we have received leaves on us the impression that competitions are, as a rule, a waste of time and money. It is claimed by their supporters that they not only give new men a chance, but promote progress and the introduction of new ideas. Unfortunately experience in this respect is paradoxical. Apart from personal and other considerations which affect the number and quality of the competitors, it seems that originality is not conducive to success in competitions, even where the conditions of the competition allow of it, and that they result in the perpetuation rather than in the improvement of well-established models. Competitions also preclude discussion between the architect and his client while the plans are in a preliminary stage (a matter of special importance in the case of schools), and also render the subsequent modification of the successful and finished plans a difficult and sometimes embarrassing matter.

15. In one respect the employment of a local architectural staff, or at any rate of an architect with local knowledge, may effect substantial economy. We have received evidence that, in certain cases, the specifications for school buildings have contained directions for the use of materials which had to be brought from a distance, when equally satisfactory materials could be obtained at a cheaper rate in the immediate neighbourhood of the site. It is obvious that, especially in respect of knowledge of local materials, as well as in connection with the

special customs and tastes which prevail in many parts of the country, there are considerable advantages on the side of employing the man who has practical experience of local conditions.

16. The last paragraph may appear to suggest a comparatively unimportant source of economy; but we are satisfied that, even under the present building regulations, a very material saving in the cost of schools as a whole can be, and has been, effected by attention to this and similar points, each of which in itself may seem small. Our detailed examination of the items in cases where thoroughly satisfactory school buildings have been provided at a cost below the average shows that *the reduction in expenditure has been obtained, not by any remarkable devices, but by a careful attention to small savings on numerous items.* It is impossible to lay too great stress on this proposition, which is further illustrated below (par. 23).

C.—Actual Cost of Elementary School Buildings as erected at present.

17. In estimating or comparing the cost of schools it is a common practice to take the average cost per unit of accommodation provided. As Elementary Schools do, roughly speaking, contain much the same accommodation for each scholar, this basis of comparison is a useful one, but it is always necessary to ascertain and state precisely what is included. As it is desirable to arrive at the total cost of the undertaking, when considering the expenditure likely to be incurred in the erection of a new school, the usual plan of adding together the cost of the buildings, playgrounds, boundary walls, and outbuildings, and dividing by the number to be accommodated, has the balance of advantage; although, of course, the margin of possible differences and the difficulty of comparison is thereby increased. Where in this Report the cost per head is mentioned, it is to be assumed, unless specially stated to the contrary, that it includes the whole cost of the main buildings, offices, playgrounds, boundary walls, heating, lighting, and washing appliances, ready for occupation and use, but exclusive of the cost of the site and furniture, and architect's fees.

It is obvious, however, that the provision, or omission, of a Hall will have an important bearing upon the cost, as will also the extent to which special rooms for instruction in Cookery, Laundry, Manual Training, and Elementary Science are included: it is also necessary, therefore, for purposes of comparison to adopt a unit which indicates the actual cost of construction, and we have not been able to find any unit more convenient or more likely to give on the whole a fair result than the cost per cubic foot, *i.e.*, the total cubic contents in feet of the main buildings divided by the total cost of the school premises, including playgrounds,

outbuildings, &c., but excluding site, furniture, and architect's fees.

18. The first point that emerges in such an inquiry as this is that not only is there a wide divergence in the actual cost of school buildings in different parts of the country, but the cubical content per unit of accommodation also varies considerably with different plans. As the floor space and height of classrooms are practically determined by the regulations of the Board of Education, this variation arises from and represents economy or waste of space in corridors, roofs, halls, and so forth. An examination of a number of typical plans shows that, while it is possible to design schools including central halls at a rate of 400 to 450 cubic feet per head of accommodation, it is by no means uncommon to find the amount running up to 500 or even 600 cubic feet per head. A school without a hall will contain from 300 to 350 cubic feet per head, according to the width of the corridors. Probably the difference in the cubical contents of buildings per head of accommodation is one of the most important factors in the wide difference in cost; and reference to this factor affords the best check on the planning and design of the building.

19. From evidence submitted to us, it appears that, in counties where bricks are cheap, such as Staffordshire, Derbyshire, Lancashire, &c., the main building can be reckoned at $4\frac{1}{2}d.$ to $5d.$ per cubic foot, to which about $1d.$ would have to be added to cover the cost of playground, offices, &c. A school, therefore, economically planned and erected, in a district where building is cheap, including a hall, outbuildings, playgrounds, &c., would cost according to ordinary practice from $10l.$ (at, say $6d.$ for 400 feet) to $11l.$ a head.

It may be taken that a school building with a suitable and sufficient provision of hall accommodation (say, a common hall for boys and girls and a smaller one for infants), but without any special rooms, should cost from $33s. 4d.$ to $37s. 6d.$ per head for every penny per cubic foot that a building of the school type may reasonably be expected to cost in the district, including all work to make school and playground ready for occupation; thus:—

	at 33/4	at 37/6	
	£ s. d.	£ s. d.	
Building at $6d.$ per cubic foot	= 10 0 0	11 5 0	per head.
Building at $7d.$ per cubic foot	= 11 13 4	13 2 6	per head.
Building at $8d.$ per cubic foot	= 13 6 8	15 0 0	per head.

These figures assume that there is nothing in the site or locality which would entail extraordinary expenditure, and, though they allow for halls, do not allow for rooms appropriated exclusively to special instruction.

20. In the case of a school to accommodate very small numbers, there is naturally a much wider range of cost, since a very slight increase or saving will make a great difference in the

cost per head ; but, as these small schools do not usually have halls, and the walls and roof can be kept low, it will be found that under favourable circumstances they can be built for a much lower figure than that given above, cases of schools recently built for 7*l.* a head having been brought to our notice.

21. The cost per head may be analysed more or less roughly in the following proportions. Taking a school for 320 "mixed" and 320 infants, erected in one storey and costing 10*l.* 17*s.* 9*d.* per head, it was found that the main structure accounts for 8*l.* 19*s.* 7*d.* per head at 4 $\frac{3}{4}$ *d.* per foot cube ; offices and drainage 14*s.* 10*d.* ; asphaltting playground 10*s.* 8*d.* ; and boundary walls 12*s.* 6*d.* Another case of a school for 156 costing 9*l.* 8*s.* 4*d.* per head gave 6*l.* 19*s.* 2*d.* for the main building at 5*d.* per cubic foot, 17*s.* for offices, 1*l.* 1*s.* 6*d.* for boundary walls, and 10*s.* 8*d.* for asphaltting.

The cost of furnishing does not vary greatly and can generally be reckoned at something between 10*s.* and 12*s.* per head. The cost of sites is naturally of too variable a nature to allow of any figures that would be much guide, on account of the wide divergence both in the local price of land and in the size of the playground compared with the school.

22. The tables in Appendices C, D, E, F, G, J, and K, giving the actual or estimated cost of a large number of schools recently erected or in process of erection in different parts of the country, will prove of interest. The cost per head in Appendix K is to be taken as including all expenses except the site, furnishing, and architect's fees.

D.—Possibility of saving on certain details.

23. We have already expressed our opinion that in the case of buildings erected under the existing Regulations and By-laws economy usually represents a number of small savings on certain items and results from close attention to the details of planning, materials, and construction.

Most of our witnesses had something to say about unnecessary expenditure on certain items or the costliness of neglecting certain obvious considerations or the way in which saving could be effected on particular items. Some of this miscellaneous evidence was not strictly within the scope of our reference, but we have for the sake of illustration summarised it under the following headings.

(i) *Sites*.—Numerous complaints were made by members of the Land Agents' Society, and submitted to us by Colonel Drummond (40), that sites are selected by Local Education Authorities without due regard to their suitability for the erection of a school, and that consequently unnecessary expense is incurred in respect of excavation and levelling, or for the purposes of a supply of water. These complaints are not without foundation, and cases have occurred in which a considerable

addition to the cost of a building has resulted from neglect to ascertain the character of the ground before purchase of the site, or from disregard of circumstances which were prejudicial to economy. It is obvious that the selection of a site is a matter which it is very difficult for a Central Authority to control, and that full advantage should be taken of local knowledge. It should also be remembered, as pointed out by Mr. Osborne Smith (144), that the aspect of a site is of importance, not only on grounds of health, but also on those of economy.

(ii) *Foundations.*—There is a considerable amount of evidence as to the value of reinforced concrete for the purposes of foundations in unstable soils. It has frequently been used in connection with school buildings, and was referred to particularly by Mr. Hutchings (67) and Mr. Jacques (73): the latter had in one case saved about 80 per cent. of the cost of foundations by adopting a raft of reinforced concrete instead of carrying piers down to the solid ballast. The conditions in this instance were rather exceptional, but a material saving may be expected from the use of this system wherever the soil is at all treacherous, and Mr. Twelvetrees (158) contended that even on fairly good ground a saving on the amount of material required for bases and footings might be effected by reinforcement.

Mr. Slater, in the paper to which reference is made below, points out that, owing to the almost universal use of cement concrete, brick footings are now practically superfluous, and greater strength at a less cost may be secured by making the footings of walls entirely of cement concrete. He estimates the average saving effected on this item at about 25 per cent.

(iii) *Floors.*—For the purposes of ground flooring Mr. Gilmour Wilson (192) considered that boards laid on concrete would prove quite as satisfactory as, and cheaper than, wood blocks. The same point was taken by Colonel Drummond (39), and is developed in an article in "Surveying" for June 3rd, 1910, on "Structural Economy," by Mr. E. A. Slater, which has been brought to our notice. Cases have, however, occurred in which such a flooring has been attacked by dry rot. Mr. Lingen Barker (2) recommended jointless floorings, such as cork adamant, as more economical in the long run than boards, on account of their greater durability, but he had not had actual experience of their ability to stand the wear of a Public Elementary School.

In upper floor construction the utility of reinforced concrete as an economical method has been widely recognised, and it seems clear that in most instances it effects a saving in cost over steel joists.

(iv) *Roofs.*—It was suggested to us by a few witnesses that some saving might be effected by the use of asbestos slating instead of ordinary slates or tiles: the economy would arise,

not from the cheapness of the covering material, but from its greater lightness, which would permit of a considerable reduction in the scantling of the roof. This point was specially pressed upon us by Mr. Lingen Barker (2), who estimated that a roof of asbestos slates would cost, including the timber work, about 15s. a square less than a slated roof, the price of which he took at 40s. a square. We have examined roofs of this construction at Harrow Sanatorium and Borstal Prison, and they seem to be satisfactory; further experience, however, is required to confirm the favourable opinions which have been expressed.

In some cases a flat roof of reinforced concrete covered with asphalte might be used, and would prove economical. For town schools this would have the additional advantage of supplying a roof playground, and would be fireproof. This suggestion was submitted to us by Mr. Twelvetrees (163) and Mr. Bradbury (4), whose experience of such roofs is favourable.

(v) *Ventilation*.—We found that the witnesses who referred to the matter were very doubtful as to the advantages of mechanical systems of ventilation whether from the economical or from the hygienic point of view. Those who spoke as experts on school sanitation were unanimous in recommending open windows for purposes of ventilation, with some simple arrangement, such as hoppers, to guide the flow of air in a proper direction, and prevent a cold draught from directly striking the occupants of a room.

(vi) *Dadoes*.—There is considerable diversity of opinion in regard to the most economical and satisfactory method of finishing the interior surface of walls. The majority of our witnesses prefer salt-glazed brick for dadoes; they agree that substitutes, such as painted cement or plaster, might be used which are equally satisfactory from a sanitary point of view and cheaper in initial cost, but think that the saving would be nullified in the course of few years by the periodical repainting needed for cement, and the greater liability of this material to damage as compared with glazed brick. Mr. Littler (81) estimated that it would not be more than 10 or 12 years before the expense of a cement dado was equal to that of a glazed brick one. On the other hand, Mr. Widdows (183) stated the first cost of a hard plaster dado, painted with composition suitable for free-arm drawing, at 1s. 8d. per yard, as against 9s. per yard for glazed brick, and the cost of repainting, which would only be needed every third or fourth year, at 5d. per yard: on these figures there appears to be a clear saving in the use of painted plaster. The relative cost, however, must to some extent depend on local conditions. There was a general agreement that, so far as school hygiene is concerned, either glazed brick or cement (including with this hard plaster) would serve equally well; in fact, we were assured by Dr. Reid (101) that he would be satisfied

with a smooth whitewashed brick wall for purposes of health, provided it were regularly cleaned. Two witnesses, Messrs. Crothall (32) and Searles Wood (115), preferred plaster or cement to glazed brick on the ground that the latter caused excessive condensation, to which Mr. Searles Wood added an æsthetic objection to the appearance of glazed brick; and there is some weight in their view. Mr. Shelmerdine (134) considered the use of glazed brick or similar dados unnecessary in schools serving a clean class of children, though necessary in other neighbourhoods; and Mr. Jacques, who gave evidence drawn from a district where a large proportion of the population is of the poorest class, stated (72) that his committee preferred varnished matchboarding for dados in classrooms and halls, on grounds partly of economy and partly of warmth, and that they found it perfectly satisfactory from the point of view of cleanliness. All the witnesses agreed that where salt-glazed bricks are used the second quality is quite good enough.

(vii) *Boundary Walls*.—Colonel Drummond (39) also drew attention to the great expense incurred in many cases by the erection of boundary walls round school sites. This expense is, according to Mr. Widdows (183), often forced on Local Authorities against their wish by the vendors of sites; and Mr. Littler (81) stated that the representatives of a district where a school is to be erected usually prefer a wall to unclimbable railings, in spite of the fact that the cost of the former, amounting in some cases to 1*l.* per school place, is about five times that of the latter. The Board of Education have, in numerous instances, pointed out to Local Authorities that expenditure on this item is unnecessary, unless the local conditions are exceptional.

E.—Novel Materials and Methods.

24. In the course of our inquiry into the use of novel materials and methods, we found some difficulty in obtaining satisfactory evidence with regard to actual experiments in construction, as hardly any school architects have used any materials other than brick or stone, except for purely temporary buildings. So far as concerns school buildings, this has been ascribed by some witnesses to the fact that local byelaws do not as a rule admit of the use of other materials. In a large part of the country, however there are no building byelaws, and in some of the areas which have byelaws provision is made for the use of other materials. The Building Regulations of the Board of Education, as has already been explained, allow a fair amount of latitude, but, by laying down definite rules for the thickness of walls, &c., they have no doubt contributed to the absence of experiment. Some, however, of the materials and methods described below might certainly have been proposed—one or two have, in fact, been proposed to and accepted by the Board—for the erection of schools.

25. The evidence we have received is not sufficient to justify us in recommending any particular materials or system of construction for general adoption, even if it would be proper for us to take that responsibility, especially as local conditions would play an important part in determining whether economy could be effected in an individual case; but it seems to us highly desirable that Local Education Authorities should make careful inquiries as to the methods best adapted to meet the needs of their own districts, and, if they can find any scheme which appears to them to provide a satisfactory and economical school building for their own purposes, should submit it to the Board of Education.

26. The methods which have been proposed to us may be roughly classified as follows:—

- (i) *Steel Frame Buildings*:
 - (a) with thin solid curtain walls of concrete;
 - (b) with hollow curtain walls of concrete slabs;
 - (c) with curtain walls of brick, hollow or solid;
 - (d) with curtain walls of patent materials;
 - (e) with hollow curtain walls of expanded metal faced with cement and plaster.
- (ii) *Reinforced Brickwork.*
- (iii) *Ferro-concrete Buildings.*
- (iv) *Brick Buildings with Solid 9-inch Walls.*
- (v) *Brick Buildings with Thin Hollow Walls.*
- (vi) *Timber Frame Buildings with Slab Casing.*
- (vii) *Wooden Buildings.*

This classification is only adopted for convenience in dealing with this subject, and it will, of course, be understood that the various methods described are capable of combination in many ways.

- (i)—(a) *Steel Frame Buildings with Thin Solid Curtain Walls of Concrete.*

27. Particulars of a building actually erected for the purposes of a Poor Law School at Anerley were submitted to us by Mr. Cecil Sharp (127). The plans of this building did not come before the Board of Education, as it is part of a Poor Law School, but the publication in the "Builder" of 5th June 1909 of plans and particulars has aroused interest among certain Local Education Authorities, and Mr. Shelmerdine (136) explained to us that the Liverpool Education Authority proposed to try a somewhat similar type of building at Liverpool. He intended, however, to make the walls rather thicker than those at the Anerley School, the total finished thickness of the concrete slabs, rough-cast outside and plastered on the inner surface, amounting to $4\frac{1}{4}$ inches at Liverpool.

28. The buildings at the Franco-British Exhibition are erected on this principle of steel frames and concrete slabs, upon

which is placed the external cement and internal plaster treatment. Mr. Hawkins, who was responsible for the erection of a large amount of this work, thought that the method would serve admirably for schools, but for that purpose he would advocate rather more care and finish in their erection—particularly as to the thorough drying of the concrete slabs, and in the external treatment of the walls. Certain suggestions on this are included in the abstract of his evidence (58). From his experience he was convinced that a concrete slab wall, with cement rough-cast outside, giving a total thickness of 4 inches, would make a comfortable and satisfactory building.

Other witnesses suggested and advocated this form of construction, but had not any actual experience from which they could furnish particulars.

29. As regards the cost of such buildings, it was stated (128) that the school at Anerley came to $5\frac{1}{8}d.$ per cubic foot, or $8l. 4s. 6\frac{1}{2}d.$ per head. In this case the central hall was of an unusually large size as compared with those generally found in Elementary Schools, and Mr. Sharp reckoned that if the hall were reduced to the normal size the cost per head would be $7l. 8s. 1d.$ On the other hand, this cost does not include any expenditure on playgrounds or boundary walls. This may well be compared with the average cost of three schools, erected of brick and with due care for economy in design and construction, at Croydon, which worked out to $11l. 12s. 6d.$ per head. The similar building at Liverpool is estimated to cost $8l. 2s. 10d.$ per head, as compared with $11l. 1s. 0d.$ per head for the latest brick school erected by the Liverpool Education Authority.* In both cases the figures cover the cost of playgrounds, outbuildings, and necessary boundary walls. Mr. Hawkins gave estimates (61) which suggested that buildings of this type could be erected at a still lower cost, stating that he was of opinion that for the building itself the work could be done at $4\frac{1}{2}d.$ a cubic foot, which would represent a cost of less than $7l.$ a head for an ordinary Elementary School with a moderate-sized hall.

In examining the cost of such schools, it must be remembered that the thin walls enable the same accommodation to be provided with fewer cubical feet per head, so that a comparison of the costs per foot cube does not show the whole of the saving in favour of the thin-walled building.

30. Mr. Hawkins (62) compared the cost of various schools recently erected in brickwork by the Middlesex and Surrey Education Committees with the probable cost of similar buildings designed with steel frames and concrete slabs, and concluded that the latter system would effect a saving of approximately 22 per cent. on the gross total cost of permanent

* Figures showing the relation of a shorter loan period to reduced first cost of buildings are given in Appendix P.

schools, while for semi-permanent works the saving could be made at least 33 per cent. Mr. Crothall (34) estimated that, in one particular case, an even greater economy would have resulted from the use of steel and concrete; in this instance all building materials had to be brought from a distance, and consequently a school for 216 children had cost 3,112*l.*, whereas in steel and concrete it might have been put up for 1,000*l.* We should not think, however, that it would be safe to conclude that, under ordinary circumstances, the methods described above would be more than from 20 to 25 per cent. cheaper than brick construction.

31. As regards cost of maintenance, it must be admitted that certain difficulties have arisen in connection with the cracking of the concrete filling, owing to the expansion of the steelwork, or the lack of rigidity of the thin curtain walls; these defects can probably be prevented by improvements in design. The maintenance of an equable temperature in such buildings would, however, probably be found more difficult and expensive than in a brick building. Those witnesses who were specially qualified to speak on questions of school hygiene were unanimous in the view that the heating surface necessary to maintain a suitable degree of warmth in buildings with walls only 4 inches thick would be disproportionately large, unless ventilation was sacrificed. It is obvious also that thin walls with a hard surface are likely to cause much condensation of moisture during quick changes of temperature, thus making the rooms chilly and uncomfortable unless special arrangements are made for heating them. We are informed, however, that at Anerley it has been found possible to maintain a mean temperature of 55 degrees with a heating surface of 21½ square feet per 1,000 cubic feet. On the other hand, it was suggested by one witness that such a building would be nearly as hot in summer as one of iron; at Anerley, however, we are informed that no such inconvenience has been experienced.

(i)—(b) *Steel Frame Buildings with Hollow Curtain Walls of Concrete Slabs.*

32. Some of the objections to steel and concrete buildings mentioned in the last paragraph could be obviated by forming a double wall of concrete slabs, with a space between. This scheme was suggested to us by Mr. Cecil Sharp (130), who stated that he would prefer hollow to single walls, and had designed a special type of concrete block for this purpose, which would obviate the difficulties arising from expansion and contraction of the steel work. The desirability of making concrete walls hollow was pointed out by Mr. Searles-Wood

(119); and the principle of a double filling of concrete slabs was accepted by Mr. Jacques (74).

We are not aware that any buildings have been planned or erected on such a system, and have no materials on which to base any estimate of the probable cost. But it appears to us that the method is worth further investigation and experiment and would probably result in a more satisfactory type of school for practical purposes than one in which the walls were of a single thickness of concrete blocks, though the saving in first cost would probably be considerably reduced.

(i)—(c) *Steel Frame Buildings with Curtain Walls of Brick.*

33. Some of our witnesses were of opinion that, if steel framework construction were adopted, a filling of brickwork might be found as economical as one of concrete. Mr. Jacques (74) had investigated such a scheme, and estimated that, in a school for 1,000 children, built with double $4\frac{1}{2}$ -inch brick curtain walls, there would be a saving of something like 25 per cent. on the cost of the external walls, as compared with ordinary methods. This system would also secure some economy in the foundations, as the weight of the building would be reduced, and it would not be necessary to have so wide a bearing surface.

This method, like the last, seems to us to offer points worthy of consideration, and to be likely to prove of service in some localities. Whether hollow brick or concrete filling in connection with steel framework would prove cheaper would be largely determined by the circumstances of the district in which the building was to be erected; so far as the comfort of the school for teaching purposes is concerned any difference would probably be in favour of brick.

34. We inspected some barracks recently erected at Bordon Camp, under the direction of Brigadier-General Scott-Moncrieff, who showed us the buildings and described the method of construction. The system adopted was that of a steel structure, the walls being filled in with brickwork $4\frac{1}{2}$ inches thick, rough-cast on the outside. The same method had been successfully used for the construction of riding schools. It is claimed that by this method a very great saving on the cost of the usual form of barrack construction is effected. The men, when questioned, stated that they found the rooms warm and comfortable in the coldest weather. It must be remembered, however, that the conditions in a school are not altogether comparable to those of barracks, and we doubt whether such thin walls would be suitable for rooms where the children are forced to sit close against them. For the purpose of a detached assembly hall, however, such a method of construction would be more suitable, especially if the $4\frac{1}{2}$ -inch walls were strengthened by wire reinforcement as described below.

(i)—(d) *Steel Frame Buildings with Curtain Walls of Patent Materials.*

35. Various forms of patented blocks are used for forming the curtain walls of a steel or wooden framed structure. We investigated one known as "Frazzi," which has been widely used. It has very much the appearance and constitution of terra cotta, and is made up into hollow blocks measuring about 2 feet by 1, and 3 inches thick, strengthened internally by ribs running down the full length of the block. It is claimed that these blocks when cemented together have sufficient strength and rigidity, in the case of small buildings, to stand and carry the weight of the roof; where there are long lengths of walling without any cross walls a steel upright is required, while in large buildings of more than one storey a complete structure of steel is erected and the blocks are used simply as a filling. It is further claimed for them that, being hollow, or rather perforated, they resist rapid changes of temperature, while the comparatively soft and porous surface prevents condensation on the inside. It is necessary to cement the outside, as the blocks are not waterproof. These blocks have been in use in Italy for many years for forming internal walls, but are not there used for external work.

36. Particulars of two hospitals erected with this material, at Windsor and Benenden, were furnished by Mr. William West, the architect (177), and we visited the first-named under the guidance of the director of the Frazzi Company. In these cases the material is used to fill in a steel-framed structure, and is rough-cast on the outside. The building appeared to be satisfactory and was well spoken of by the occupants.

The open-air school at Thackley built by the Bradford Corporation, of which Mr. Kirkby, the borough surveyor, has supplied particulars (Appendix L), is also erected in this material, being rough-cast on the outside and left plain on the inside, the surface of the block showing. The same material has been used, we understand, for churches and private houses.

37. An equally satisfactory building for school purposes could probably be obtained by the use of other hollow blocks or by means of hollow walls of brick or concrete. It would depend on local conditions which material would prove most economical. Mr. Fisher informed us (54) that he had obtained alternative estimates for a building in reinforced brickwork and in steel with Frazzi filling, and found the former slightly cheaper in the particular case, as bricks were cheap in the locality; but he would expect the difference to be on the other side and in favour of Frazzi where bricks were not readily obtainable. The director of the Frazzi Company has supplied us with estimates (Appendix M), from which it appears that, for the walls of an ordinary building, he claims that his system would effect a saving of about 40 per cent. as compared with brickwork.

38. Another patent slab known as the "Fram" is described below in the account of the Harrow Sanatorium, and there seems to be no reason why others of the numerous forms of slabs used for internal partitions should not be used for external walling, if suitably treated to render them waterproof; but, unless the slab is itself hollow, it is desirable to have a double wall in order to secure an airspace.

(i)—(e) *Steel Frame Buildings with a Hollow Curtain Wall of Expanded Metal faced with Cement and Plaster.*

39. A proposal has been submitted to the Board of Education for the erection of a school at Nacton, in East Suffolk, on a method which has been extensively employed for cottages on Captain Pretymann's estate. A steel framework is constructed, strengthened by cross-wiring, and this frame is filled in with expanded metal lathing on both sides; the outer side is faced with a layer of cement and rough-cast $1\frac{1}{2}$ inches thick, and the interior with $\frac{3}{4}$ inch of plaster, a cavity $6\frac{1}{2}$ inches wide being left between the two sides; the lower part of the wall is built in brick up to plinth level, or, in the case of a school, to the under side of the window sills. Cottages designed on this system have been visited, and the result appears to be satisfactory, and there is no reason to suppose that it would be unsuitable for school purposes. In this particular district the high cost of brick building enables this form of construction to be used at 25 to 30 per cent. less cost than brick, but from the figures supplied it seems doubtful whether any saving would be effected where bricks can be obtained at all readily.

40. In regard to steel frame construction generally, whatever form of filling may be adopted, attention has already been drawn to the fact that considerable economy would be effected in the space occupied by a school building, owing to the diminished thickness of the walls: Mr. Riley (110) estimated the saving in area at 8 per cent. A further advantage, which has also been mentioned above, and is common to all forms of steel framework, is the economy in foundations rendered possible by the lighter building; and on an insecure foundation a wall contained in a steel frame is certainly safer than a plain brick wall. On the other hand, all the forms of filling proposed require to be made weather-proof by a facing of cement rough-cast or a similar material; and Mr. Jacques (75) suggested that there are objections to the use of rough-cast in a smoky atmosphere. It is obvious also that this method of construction calls for a special treatment of the elevations, if the buildings are to be sightly as well as cheap.

(ii) *Reinforced Brickwork.*

41. A method of forming double walls, which it is claimed secures adequate constructional strength, while permitting each

wall to be built of $4\frac{1}{2}$ -inch brickwork, or even 3-inch by the use of brick on edge, was brought to our notice by Major H. S. Rogers, Surveyor to the Prisons Commission, who has used it extensively in prison work and showed us a building in course of erection at Borstal Prison. In this case, a two-storied building, the weight of the roof is carried on ferro-concrete piers, built up on the spot. The method upon which the walls are constructed is known as "Reinforced Brickwork," and consists of the use of strips of galvanised wire netting, strengthened by longitudinal wires and made of a suitable width to be entirely buried in the thickness of the wall, placed in every third or fourth course of the brickwork. This is said to increase the strength of the wall to a very marked degree, and to offer great possibility of economy in dealing with difficult sites and insecure foundations. It is also claimed that in ordinary cases there is no need for continuous foundations, as a wall will carry itself if supported every 10 or 15 feet; that there is no need for lintels, as by the use of reinforcement the brickwork can be carried over ordinary openings; and that in other details, such as fixing door and window frames, there is a saving.

42. Where the walls are built hollow on this system ties of wire netting are carried across from wall to wall. Owing to the thinness of the wire it appears that such netting, where not buried in the wall, might be liable to rust through; but in view of the strength of each individual wall and the frequent points at which they would be tied together constructionally, the likelihood of failure from this cause is not great. The ordinary ties used for hollow walls are, of course, equally applicable to this form of construction.

43. As regards cost, it is stated that a wall, built of brick on edge and reinforced every other course, in 2 to 1 cement mortar, will, in normal cases, cost about 2s. $7\frac{1}{2}$ d. per yard super.; this will be reduced to 2s. $3\frac{1}{2}$ d. if the reinforcement is put in every third course. A $4\frac{1}{2}$ -inch wall will cost 3s. 11d. and 3s. 5d. respectively per yard super.

We have not any precise data for estimating the cost of this method as applied to schools, but it may be assumed that it would only exceed very slightly that of an ordinary 11-inch brick hollow wall.

44. A modified form of hollow brick wall is now being tried by Mr. Fisher for the Berkshire Local Education Authority (53); in this the wall is formed by two 3-inch thicknesses of brick on edge, reinforced with steel wire mesh, and a 3-inch space between; the weight is taken on piers of solid 9-inch brickwork reinforced, so giving a 9-inch wall throughout which is hollow between the piers. The estimate for a Cookery and Handicraft Centre in this construction was 500l. exclusive of fittings, while a centre of similar area built in 14-inch brickwork

had cost 900*l.*; on the actual walling the saving in the former case as compared with the latter appears to be about 25 per cent., and there is also considerable economy in foundation work. If the bricks are laid flat, instead of on edge, there will, of course, be a greater amount of material used, and consequently hollow walls with 4½-inch thicknesses might be expected to be proportionately dearer than those with 3-inch thicknesses of brickwork; but we are informed that experience at Borstal Prison tends to show that the greater ease of laying bricks flat would compensate, at all events to some extent, for the saving of material effected by laying them on edge.

45. The evidence seems to us to be in favour of the conclusion that hollow walls of reinforced brickwork might prove suitable and satisfactory for school purposes and under some conditions might also be economical.

(iii) *Ferro-concrete Buildings.*

46. We have received a considerable amount of evidence as to the possibility and advantages of employing for school buildings the various types of ferro-concrete construction. Many school architects have gone into this question, and in two or three cases tentative proposals for its use have been made to the Board of Education. Although, however, the Board have expressed their willingness to give favourable consideration to plans for the use of this construction, we understand that none have actually been sent to them, and no case has been brought to our notice in which a school has been erected in ferro-concrete.

47. The main reason why ferro-concrete has not been adopted for schools is that it is considered too expensive for buildings of this character. The evidence given to us was to the effect that where estimates have been obtained, it has been found that the cost of a ferro-concrete building was, as a rule, higher than that of a brick one. For instance, Mr. Widdows (184) quoted to us alternative tenders for ferro-concrete and 14-inch brick for a single-storey school of 150 places; the former came out at 1,878*l.* 12*s.* 3*d.*, and the latter at 1,750*l.*, giving a margin of 7 per cent. in favour of brick. Mr. Littler (82) said that he found the price for walls 6 inches thick in ferro-concrete was 7*s.* a yard, whereas a 16-inch brick wall would cost in Lancashire 6*s.* 4*d.* a yard. Mr. Rees (97) had prepared plans for a school in ferro-concrete on an exactly similar scale to the latest school he had erected in brick, and the estimate given him for the ferro-concrete building was 8,639*l.*, while that for the brick one was 7,230*l.* So far as this evidence goes, it points to the conclusion that in the case of a building on one floor, the normal plan for a school, there is no saving by the use of ferro-concrete for walls, unless there are very exceptional circumstances which

make ordinary methods of construction unusually costly. The expense of shuttering and centring seems to absorb any saving in the material, and the general design of schools, with their large areas of window-space, does not lend itself to economy in this method.

48. We heard some general objections to the employment of solid ferro-concrete for schools, of the same character as those made in regard to steel-framed buildings, in respect of the thinness of the walls. It would probably be necessary for extra heating surface to be provided for a ferro-concrete school, which would be exposed to the drawbacks from rapid changes of temperature to which attention has been called in connection with curtain walls formed of thin concrete slabs.

49. From the point of view of the Board of Education a more serious problem is involved in the constructional risks which admittedly attach to the method, if it is employed without qualified technical advice in the planning and skilled supervision in the actual course of construction. The margin of safety in this form of construction is usually small, and thus a slight error in calculation or any scamping of the work is proportionately a more serious matter.

50. It appears to us, on the other hand, that, under proper regulations, a limited use of ferro-concrete might be found economical. Mr. Twelvetrees (157) suggested that a school might be designed on the general principle of a steel-framed building, but with a reinforced concrete skeleton instead of steel; the same kinds of filling—concrete slabs or bricks—could be used as with steel. He estimated (159) that reinforced concrete for the purposes of columns would give a saving of about 25 per cent. as compared with steel to carry the same loads, and that a building with such a skeleton would cost from 10 to 20 per cent. less than either a steel-framed or a brick building. Mr. Crothall (33) submitted particulars of a school actually designed by him on this principle, having ferro-concrete piers with a double-curtain wall of 3-inch concrete slabs 2 inches apart, rendered outside with cement, some red brick being used in front for the sake of ornament. This plan was on the same lines as one of a school for 320 children lately erected in brick at a cost of 4,734*l.*, and he estimated that on the new plan the school could have been built for 3,200*l.*

A design such as that suggested in the last paragraph might be considered with advantage in localities where there are facilities for making concrete; but it would be necessary, as in the case of a building planned wholly in ferro-concrete, to obtain proper expert advice in regard to constructional details, and great care and close supervision during construction would also be necessary.

(iv) *Brick Buildings with Solid 9-inch Walls.*

51. The Board of Education have several times been asked by Local Authorities to sanction plans showing solid brick walls only 9 inches thick. We find that there is practically unanimous agreement amongst our witnesses that a plain 9-inch brick wall would be satisfactory if covered with rough-cast or cement or other impervious surface, especially in the case of small single-storey country schools; it is, however, doubtful whether it would, at all events if built in mortar, give sufficient constructional strength, in view of the long walls without cross walls that a school requires. If, therefore, it is necessary to build such a wall in cement and buttress it at intervals, any saving effected in comparison with a 14-inch wall would be materially reduced. Mr. Wilson (193) stated that he had gone carefully into the question whether it was more economical to build a thin wall with buttresses or to thicken it throughout, and concluded that the latter was the cheaper method in ordinary circumstances, as well as having the advantage that projecting corners were avoided.

52. On the whole, while it does not appear to us that any great saving would be effected by the adoption of 9-inch in place of 14-inch brick walls, we are of opinion that a 9-inch wall, if properly supported and suitably treated on the outside with rough-cast, cement, stucco, tile hanging, or other material which will ensure dryness and contribute to warmth inside, might be permitted for school buildings.

(v) *Buildings with Thin Hollow Brick Walls.*

53. As regards the suitability for school purposes of 11-inch brick walls, built with two thicknesses of $4\frac{1}{2}$ inches and a space of about 2 inches between, we have found considerable diversity of opinion. Most of our witnesses regard such walls as better than 9-inch solid brick walls for retaining warmth and resisting damp, but inferior in constructional strength and objectionable on account of their tendency to transmit sound. Mr. Widdows (185) was distinctly adverse to their use, as he thought that such walls were bound to be damp inside, and the ties might rust away unobserved: he preferred a solid 9-inch wall rough-cast. On the other hand, Mr. Burrows (18) has found such walls satisfactory in his experience, while Mr. Jacques (76) was of opinion that an 11-inch hollow wall would be impervious to damp and, from its wider base, more stable than a 9-inch solid wall.

(vi) *Timber-framed Buildings with Slab Casing.*

54. Mr. Osborne-Smith (145) described to us a sanatorium erected by him at Harrow, on a method which he considered would be suitable for school buildings, and we subsequently

visited it under his guidance. The outer walls are formed of timber framing 4 inches thick, cased on the outside with "Fram" slabs 2 inches thick, and on the inside with similar slabs 1 inch thick; the outside is finished with cement rough-cast. This appears to make a sound and comfortable building. Mr. Smith suggested that, for schools, it would be desirable to make the interior lining of slabs 2 inches thick to dado height, to guard against the risk of injury from blows.

The cost of the Harrow Sanatorium was 6*d.* per foot cube for the building alone, on a very difficult and hilly site; under favourable conditions it could, according to Mr. Smith, have been erected for 5*d.* It is not easy to say what saving could be effected by the use of this method of construction for schools under ordinary circumstances, but it may repay further investigation by Local Authorities in cases where the necessary materials can easily be obtained.

(vii) *Wooden Buildings.*

55. Several Authorities have approached the Board of Education with proposals for the erection of schools constructed entirely of wood, and in a few cases such buildings have been approved for temporary use.

A system widely used for such purposes in Germany, and known as the "Doecker" patent system, has been tried by the Education Authorities in Derbyshire, Carnarvonshire, and Kent. The system, which is described in a Report made to the Board of Education in 1907 (*see* Appendix N), consists of timber framing, covered on the outside with weatherboarding and on the inside either with matchboarding or some fireproof material laid on in large sheets, the hollow space between being filled with some non-conducting material such as powdered cork or sawdust. The roof is made double, with arrangements for giving through ventilation in the space above the ceiling. The special feature of the system is an ingenious arrangement of hooks and eyes by means of which the building can be easily and quickly taken down and re-erected in another position. There is, however, not the same advantage, in the case of schools as in the case of field hospitals and camp buildings, in this extreme quickness and ease of removal, and all the essential and important features of such buildings can be secured anywhere at a very much lower cost by due care in design. Mr. Widdows (189) informed us that the Doecker School at Long Eaton, for 220 children, had cost 954*l.* for the building alone, 74*l.* for plumbing, lighting, &c., and 80*l.* for foundations; and he had recently obtained estimates for an exactly similar wooden school which came out at 748*l.* for the building.

56. Generally we found a decided opinion that wooden buildings were more comfortable and satisfactory than buildings

of corrugated iron lined with wood. If, however, they were cheaper in first cost, they would probably require a larger expenditure for maintenance in painting, &c.

It is probable that some form of wooden construction will prove the most satisfactory and economical for temporary schools, under ordinary conditions. When required for short periods only, the buildings might be erected on sleepers; otherwise the buildings should be raised from the ground on brick foundations.

57. The chief objection to wooden buildings is the risk of fire; but in country schools this risk is practicably negligible so far as the safety of the scholars is concerned, if the building is on one floor and suitable means of exit to the open air by windows or otherwise from each room are provided; and as such schools would naturally be isolated from surrounding premises, there would be no general danger to the public. It is also possible to reduce this risk by the use of a non-inflammable wall lining.

F.—Byelaws and Building Acts.

58. We have already drawn attention to the fact that some novel forms of construction, even if permitted by the Building Regulations of the Board of Education, would not satisfy the local building byelaws in many districts. This point has been pressed upon our notice by almost every witness whom we have examined. The difficulty arises from the fact that the byelaws are and must be precise and definite, and do not permit of relaxation at the discretion of the Local Authority or their officers. The byelaws commonly exempt from their operation buildings erected under the approval of a Secretary of State and some other Departments, but hitherto this exemption has not been extended to school buildings. In London, where building is subject not to byelaws but to the provisions of the London Building Acts, there is the same want of provisions for the exemption of school buildings.

A memorandum relating to exemptions from local byelaws will be found in Appendix O.

59. It was the unanimous opinion of our witnesses that school buildings should be placed on the same footing as buildings erected under the approval of a Secretary of State and other buildings exempted from the operation of local byelaws and Building Acts, and that legislation should be promoted for this purpose. They regard it as quite sufficient guarantee for the soundness of the structural design of a school that the plans should have been passed by the Local Education Authority and the Board of Education. Some of the witnesses would limit the exemption of school buildings from the byelaws to the plans of the actual structure, and would still require the drainage scheme, as a matter touching the public health of the district, to be submitted to the Local Sanitary

Authority; but others are of opinion that the approval of the schemes in this respect by the Local Government Board is sufficient.

G.—General Conclusions.

60. We have been much impressed in the course of our inquiry with the great economies which can be secured by good designing, careful attention to details of construction and finish, and by keeping in view the probabilities which affect the "useful life" of school buildings. Taking the country as a whole, it is probable that for some time to come there will be as much saving effected in the erection of school buildings by skilful and businesslike employment of methods and materials in ordinary use, as by adoption of novel methods and materials. The work of the school architect is particularly difficult. He is or ought to be working to a progressive standard, determined by educational considerations which cannot be fully grasped without much study and experience. His clients are sometimes imperfectly acquainted with these considerations or hamper him with irrelevant instructions. The intentions of those Authorities who depend on competitions for getting the most economical and up-to-date designs are no doubt excellent, but they usually defeat themselves. The greatest Local Authorities are not always the most progressive, or, in spite of their complaints of the growing burden of the rates, the most active in seeing that they get good value for the money sunk in school buildings. We have already expressed our admiration of the work which is being done in certain areas by school architects working under enlightened and business-like Local Authorities. Whatever materials or methods of construction they may adopt in the future, we look with some confidence to their example to effect a substantial reduction in the average cost of school buildings coupled with an increase in their efficiency.

61. We have been embarrassed in our inquiry by the small number of buildings erected on novel lines which are at all comparable with school buildings, or which would enable us to judge how far the methods and materials employed are really suitable for school purposes. We find it difficult therefore to speak with much confidence on this point, and our recommendations can amount to little more than an expression of opinion in favour of experiment. Most of the witnesses who have assisted us were themselves commendably modest in their claims for the systems they advocated, and very candid in discussing objections to them. The scarcity of experimental school buildings is attributable partly to the natural preference by architects for materials and methods with which they are thoroughly familiar (the specification of which is a mere matter of routine) and which require comparatively little supervision of the work in process of execution. It is also attributable to a great extent to the fact that the Building Regulations of the

Board of Education do not contemplate and do not encourage experiment in novel materials or methods, and that in areas where the other conditions are most favourable to experiment the building byelaws do not admit of it.

62. We have accordingly found ourselves obliged, in dealing with our reference, to consider ourselves as mainly concerned with the questions (a) do recent developments in building practice show a fair promise of reducing the cost of school buildings if existing obstacles to experiments in construction are removed; and, if that question is answered in the affirmative, (b) what steps can and should be taken to facilitate such experiments?

We do not regard ourselves as competent to pronounce authoritatively, as a technical Commission might pronounce, for or against particular devices; but, after making all allowance for the great difference in cost, as well as in efficiency, between good and bad school planning and good and bad construction with ordinary materials, and for the possible saving by means of greater care and skill in their use, we are satisfied that several of the suggestions made to us are distinctly promising and offer a fair prospect of further saving. We therefore feel justified in answering the first question in the affirmative. As regards the second question, we have no hesitation in recommending that the existing obstacles to experiment should be removed, and that the Board of Education and the Local Government Board should be placed in a position to facilitate the execution of such proposals for the use of new materials or methods of construction, submitted to them by or through Local Education Authorities, as commend themselves after due consideration. While we do not contemplate or anticipate anything like a sudden revolution in school building, we do not on the other hand consider that either the Local Education Authorities or the Government departments concerned are justified in maintaining an unduly conservative attitude.

H.—Recommendations.

63. We do not consider it desirable that we should attempt to discriminate between the several methods and materials submitted to us to any greater extent than is involved in the criticisms made on them in the preceding paragraphs, and we do not propose to recommend specifically the use of any of them (or of any combination of them) in preference to others. We feel, however, that we are justified in recommending—

- (i) That Local Education Authorities should be encouraged to submit specific proposals for the use of novel materials or methods for Public Elementary Schools.
- (ii) That it should ordinarily be made a condition of the approval of such proposals that such provision as is practicable should be made for the periodical inspection of the structure.

- (iii) That, for the purpose of facilitating the use of novel methods and materials (a) legislation should be promoted to exempt school buildings the plans of which have been passed by the Board of Education from the operation of local building bye-laws and corresponding provisions in Local Acts; (b) the Building Regulations of the Board of Education should be revised so as to remove any difficulties placed by them in the way of the adoption of such methods or materials.
- (iv) That, where proposals are approved for the use of novel methods or materials, such as those described in paragraphs 27 to 54, in the erection of permanent schools, a loan period of 30 years should, until further experience is available as to the durability of such structures and their immunity from repairs, be regarded as normally appropriate to such cases.

64. The effect of our last recommendation is illustrated by the tables in Appendix P, from which it appears that if a saving of from 20 to 22 per cent. were effected in the first cost of a building by the adoption of novel methods, the annual loan charges for a period of 30 years would not be greater than those for the period of 50 years allowed in cases where ordinary methods are used, and no such saving in first cost is shown. The shorter loan period, of course, shows a great saving in the total amount of the loan charges paid during the whole period.

L. A. SELBY-BIGGE.
NOEL T. KERSHAW.
FELIX CLAY.

J. GRAFTON MILNE,
Secretary,
December 6th, 1910.

ABSTRACT OF EVIDENCE.

[The Abstracts of Evidence were submitted to and approved by each of the witnesses.]

LIST OF WITNESSES.

A. Nominated by Local Education Authorities :—

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<i>Berkshire</i> - - Mr. E. FISHER, Architect to the Education Committee - - -	47
<i>Birkenhead</i> - - Mr. T. TALIESIN REES, F.R.I.B.A., Architect to the Education Committee - - -	61
<i>Cambridgeshire</i> - - Mr. H. H. DUNN, A.R.I.B.A., Architect to the Education Committee - - -	45
<i>Croydon</i> - - Mr. H. CARTER PEGG, F.R.I.B.A., Architect to the Education Committee - - -	58
<i>Derbyshire</i> - - Mr. G. H. WIDDOWS, A.R.I.B.A., Architect to the Education Committee - - -	85
<i>Hertfordshire</i> - - Mr. J. J. REDHOUSE, Builder - - -	60
<i>Lancashire</i> - - Mr. H. LITTLER, Architect to the County Council - - -	57
<i>Liverpool</i> - - Mr. J. G. LEGGE, Director of Education - - -	56
- - - Mr. T. SHELMEKDINE, Surveyor to the Corporation - - -	72
<i>London</i> - - Mr. W. E. RILEY, F.R.I.B.A., Architect to the County Council - - -	65
<i>Manchester</i> - - Mr. C. H. WYATT, Director of Elementary Education - - -	90
<i>Middlesex</i> - - Mr. H. G. CROTHALL, Architect to the Education Committee - - -	41
<i>Newport (Mon.)</i> - - Mr. C. F. WARD, A.R.I.B.A., Borough Architect - - -	81
<i>Staffordshire</i> - - Mr. J. HUTCHINGS, A.R.I.B.A., Architect to the Education Committee - - -	51
<i>West Ham</i> - - Mr. W. JACQUES, A.R.I.B.A., Architect to the Education Committee - - -	53

B. Nominated by Societies :—

Land Agents' Society :—Colonel F. D. W. DRUMMOND - - 44

Royal Institute of British Architects :—

Mr. H. W. BURROWS, A.R.I.B.A., F.G.S. - - 36

Mr. J. OSBORNE SMITH, F.R.I.B.A. - - 74

Mr. W. GILMOUR WILSON, F.R.I.B.A. - - 88

Royal Sanitary Institute :—

Dr. GEORGE REID, County Medical Officer, Staffordshire - 63

Dr. H. MEREDITH RICHARDS, M.O.H., Croydon Borough - 64

Mr. H. D. SEARLES-WOOD, F.R.I.B.A. - - 67

Surveyors' Institution :—

Mr. S. H. COWPER-COLES, F.S.I. - - 40

Sir A. R. STENNING, F.S.I., - - 77

C. Other witnesses :—

Mr. E. H. LINGEN BARKER, Architect - - 33

Mr. GEORGE BRADBURY, Architect - - 34

Mr. T. ERNEST HAWKINS, Contractor - - 49

Mr. CECIL A. SHARP, Architect - - 70

Mr. W. NOBLE TWELVETREES, Engineer - - 79

Mr. A. WILLIAM WEST, Architect - - 83

I.

Mr. E. H. LINGEN BARKER, Architect, of 101, Leadenhall Street, E.C.

Actual Cost of Schools as erected at present.

1. Witness claimed that it was possible to build thoroughly satisfactory schools much more economically than would appear from the sums usually paid. He submitted particulars of 22 elementary schools erected by him for different bodies since 1870, and drew special attention to three cases:—

- (a) A large block of buildings at Tottenham opened in 1894, with accommodation for 1,420 children, including two halls, a cookery centre, and offices, which cost 13,827*l.* 11*s.*, or 9*l.* 14*s.* 9*d.* per head; if the expenses of caretaker's house, playground and foundation, fencing and gates were added, the total was 15,613*l.* 11*s.*
- (b) New schools and enlargements at Rugby, built in 1901, which cost 4*l.* 15*s.* 5*d.* per head for the enlargements, and 4*l.* 17*s.* 4*d.* for the new schools and offices, exclusive of preparation and fencing of site and fitting up of buildings.
- (c) A new school and offices at Portslade, Brighton, opened in 1903, for 250 infants, which cost 5*l.* 5*s.* 5*d.* per head.

These schools show an average cost of 6*l.* 3*s.* 3*d.* per head.

Possible Means of Economy under present Regulations.

2. Witness submitted that there were many new materials in the market which would, he thought, be permissible under the building regulations and deserved a trial, and which might prove economical in the end; the absence of demand for these goods, however, caused largely by architects hesitating to experiment, naturally raised their price. Witness strongly urged the desirability of some means being adopted for testing the durability of the many new composite materials now on the market, and he thought that those departments of the State which were interested in securing economy in building work might assist in this respect by co-operation with existing organisations. For example, the use of asbestos roofings would probably result in a great saving; they were not cheaper in themselves than ordinary slates, but so much lighter that there was far less expense in roof timbering to carry them. He estimated that a roof of this material, including the timber work, saved about 15*s.* as compared with an ordinary slated roof. He could not at present offer any opinion as to the durability of asbestos, as the material had not been long enough in use. The jointless floorings, again, of which cork adamant was certainly the best, although no cheaper as regards

first cost than deal wood blocks, would effect a saving in long run, as they were doubtless more durable; and they had a further advantage in that they were more hygienic and easier kept clean. For internal wall linings there were several efficient and economical alternatives to glazed bricks; and he instance adamant plaster, which cost one-quarter as much as glazed bricks and did not need painting; it could be obtained in different grades of polish and was washable, the only disadvantage being that it was liable to show scratch marks. Terra cotta also might be used extensively instead of stone, as well as artificial or reconstructed stone, and in many cases both would effect saving in cost, while they were altogether more dependable than their lasting qualities.

II.

Mr. GEORGE BRADBURY, Surveyor to the Diocese of Liverpool, Surveyor to late Liverpool School Board, Surveyor to late Litherland School Board, Past President of the Liverpool Architectural Society, &c.

Actual Cost.

3. Witness considered an ordinary elementary school without special rooms ought to be built for 10*l.* per head; that would allow a margin for fluctuation in cost of materials. He gave details of two schools now being built from his plans in Liverpool. The more economical of the two was Christ Church School, which was on a fairly level site. The accommodation was for 650, and the total cost on the builder's contract was 6,096*l.*, including 1,739*l.* for making up playgrounds, boundary walls, railings, heating, electric light, drainage, latrines, covered playbeds, water supply and fittings, and extra foundations. The cost of the building per cube foot was, including everything, 6½*d.*, excluding the items named, 4½*d.* At the other school, St. James' Council School, there was an adjoining building which was being altered to provide laundry and cookery centres, and two rooms for manual work, to be included in the cost, which came out at 11*l.* 11*s.* per head.

Possible Economies.

4. Witness said a two-storey building was much cheaper than one storey, even apart from the question of the land occupied, on account of the saving in the foundations and in roof area, especially if the roof were flat. In ordinary materials a school might be built at 9*l.* a head, and witness submitted the following details of construction of such a school:—

I consider the most economical school is one for say 1,000 children, in 20 classrooms of 50 each, two storeys

high, three sides of each classroom 9-inch walls, one outside wall ground floor, 1 foot 7 inches., with a 14-inch wall on the first floor. As this outside wall would be nearly all window space, there would be very little brick-work in it.

The ground floor would be placed 6 inches above the ground level, constructed of 5-inch concrete, 1-inch cement face, and then wood blocks bedded in asphalt; or in lieu of the cement face and wood blocks costing 5s., one of the patent floors might be used, costing 3s.

The first floor would be wood joists, 10 inches by 3 inches for 20-foot span, bridging, deafening, and boards on the top.

The roof would be constructed of 5-inch concrete reinforced with steel, 1-inch cement face and 1-inch Trinidad rock asphalt. The corridor would be 10 feet wide, and of fire-resisting construction; 11 feet from floor to ceiling, instead of 13 feet as now required, would greatly reduce the cost of schools.

Novel Materials and Methods of Construction.

5. The witness had obtained estimates for school building in ferro-concrete, but could not get them to come out lower than 9l. per head. It was true that patentees quoted a price of 3d. or 4d. per cube foot for ferro-concrete work, but this did not include windows or flooring. The cheapest filling material which had been brought to his notice was a composition of pumice stone and cement of Italian make. The cost of using this material in Liverpool might be put at 5s. 3d. a square yard (3s. 3d. per square yard of 3-inch slabs material, 1s. for plastering, 1s. for erection) as against 4s. 10d. for a 9-inch brick wall (3s. 10d. a square yard for building in brick, 1s. for plastering). Moreover, in concrete a wall could not be carried more than 25 feet without a stanchion, whereas brick required no further strengthening, and would carry joists. These figures applied mainly to internal walls. For external walls the Liverpool byelaws required 18 inches for the ground floor, and 14 inches above; but, as an external wall was mainly windows, the brickwork was comparatively cheap. Concrete when used externally required facing with cement or terra cotta or other waterproof material, and this facing involved great extra cost for painting and upkeep; moreover, his experience was that cement-work was never quite satisfactory; even the best cement would crack and allow the damp to come through.

6. As regards steel-frame construction, witness stated that he had obtained estimates from patentees, and was satisfied that a satisfactory two-storey building, with steel framework and weather-resisting curtain walls, could not be put up more cheaply than a similar building in brick. In addition to the stanchions,

horizontal beams would be necessary to carry the first floor, and a certain amount of cross-stiffening would be required. He had worked out the question in detail and proved it before an arbitrator in regard to a claim for reinstatement made by the managers of Christ Church School against the Liverpool Corporation.

Building Rules.

7. Witness was strongly of opinion that, in the heart of a city, 20 square feet per head was ample for playground space. He thought roof playgrounds should be encouraged, or, if the roof were not used for a playground, light buildings for manual instruction might be erected there.

8. He thought also that 13 feet was an unnecessary height for a school with classrooms for 40 to 50; 11 feet was ample, with good ventilation; if the number in a room was larger, the height should be 12 feet. There would be no difficulty as to lighting, if the windows were carried up to the roof.

III.

MR. HENRY WILLIAM BURROWS, A.R.I.B.A., F.G.S., &c.,
Consulting Architect to the National Society;
of 17, Victoria Street, Westminster.

Actual Cost.

9. Witness handed in a list of schools built by him in various parts of England during the last 12 years, all of ordinary brick construction. He pointed out that the cost of school buildings varied to a large extent with the special circumstances and conditions pertaining to different localities. It was usually cheaper to build schools in country districts, where both materials and labour could be obtained at less cost, than in or near towns where the cost of materials was usually higher, and the rate of wages on a higher scale. The average cost of his schools in country districts was 6*d.* per foot cube, or 7*l.* 16*s.* 3*d.* per place; of schools in or near country towns, 8*d.* or 10*l.* 5*s.* 2*d.*; of schools in London, 10*d.* or 13*l.* 5*s.* 7*d.* A typical London school was St. Peter's, Walworth, which was built under ordinary conditions and involved no special expenditure on foundations: the cost of this, exclusive of site and exclusive of quantities, was 9*d.* per cubic foot. In some of the London schools shown on the list there were exceptional charges for foundations, as, for instance, at Exton Street and St. Saviour's Southwark, where the wall had to be carried down 17 feet below the pavement for a foundation. The cost of quantities was excluded, because in many small country schools the expense of preparing quantities was unnecessary,

Possible Means of Economy.

10. Witness submitted that it would be more economical, as well as better for teaching purposes, to build detached halls, using one hall for more than one department, instead of the prevailing arrangement of a hall for each floor.

11. He also thought that it was normally cheaper to build in two storeys than in one; he had lately tested this in two schools designed by him, a single-storey building, giving 165,119 cubic feet and occupying 7,638 feet super. for 340 children, and a two-storey building, giving 163,533 cubic feet and occupying 4,356 feet super. for 396 children. Thus the two-storey building, for 56 more children than the single-storey one, saved 1,586 cubic feet of building and 3,282 superficial feet of land.

12. He was of opinion that a more general use of roof playgrounds should be allowed, at any rate in urban areas where land was expensive and difficult to obtain.

13. The actual cost of a building was largely determined by the methods adopted by the architect; thus a plain stock-brick building with an ordinary slated roof was far cheaper than a building finished in elaborate style. The schools built by the London County Council and other authorities cost, he understood, over 20*l.* per place, as against his 13*l.* 5*s.* 7*d.* in London. The difference was largely due to extravagance in the details, as, for instance, an extensive use of Portland, or other expensive stones, or terra cotta; an unnecessary elaboration of roofs and turrets, tower-like structures, covered with copper or other expensive material, which seem to serve no particular purpose; expensive and elaborate, specially made materials, *e.g.*, curved bricks for apsidal ends; expensive wall finishings, such as tiled dadoes, of elaborate patterns, with specially made cappings and hollow plinth mouldings; and a general over-elaboration of detail instead of a simple treatment which would be as efficient and sufficient.

Novel Materials and Methods.

14. Witness had no personal experience of any special types of concrete construction, the use of which had hitherto been prevented by the building regulations of the Board of Education. He thought that, unless the thickness of the walls and floors could be materially reduced, a concrete building would not be much, if any, cheaper than an ordinary brick building; it was impossible on the facts at present known to say at what point a thin concrete wall equals a 9-inch brick wall, and he questioned whether the reduced thickness of walls and floors would produce so satisfactory a building as one of the ordinary solid type. As regards the temperature of the building, one of the principal objections to a thin brick wall is that the building is hot in summer and cold in winter, and it had not yet been proved that a thin slab of concrete offers any better resistance

to the effects of heat and cold. He saw no reason to suppose that a thin wall of concrete would be a better weather resistor than a thin wall of brickwork, since in either case the weather-resisting properties depended mainly on the cement, tile-hanging rough-cast, or other covering material. Thin floors would be objectional on account of their transmitting sound too readily.

15. On the whole, before any definite opinion could be expressed as to the suitability of concrete for school purposes, it would be necessary to make extensive inquiries, and, possibly, to undertake a large series of experiments, but speaking generally from his own knowledge of concrete buildings, such as houses, of which he had some experience, he did not think that the results of the use of concrete were either satisfactory or specially economical.

16. As regards steel frame buildings, he thought that, if steel construction were found economical, the filling could be done as cheaply in brick as in any other material. His objection to steelwork was that it transmitted sound from end to end of the building.

17. He thought a 9-inch brick wall, with cement rough-cast or tile-hanging, would be satisfactory for school building, assuming that it was constructively strong enough to carry the loads; he preferred tile-hanging to rough-cast, as it was cleaner and needed less repair. He had built many houses, some in most exposed positions, with such walls, and found the results perfectly satisfactory.

18. He had also built hollow walls, with two $4\frac{1}{2}$ -inch thicknesses of brick and a 3-inch cavity, with equally satisfactory results; though he did not think these constructively as strong as 9-inch solid walls, and they carried sound more from room to room. He would recommend either of these methods of construction for schools. He had not considered what amount of extra heating surface would be required for buildings with thin walls.

19. He doubted whether the reduction in thickness of walls would save anything like 10 per cent. of the total cost of schools.

Building Regulations.

20. Witness submitted that the requirements of the Board of Education's Regulations might be relaxed in regard to the height of rooms, the cloakroom accommodation for boys, and the amount of office accommodation for girls and infants, and of urinal space for boys.

Byelaws.

21. Witness pointed out that a public elementary school was a "public building" as defined by nearly all the Acts relating to buildings. There was often no definite scale of thickness

of walls prescribed for public buildings, but usually the walls of public buildings and buildings of the warehouse class had to be constructed of the same thickness. That was insisted on by district surveyors in London, and some surveyors even required an extra thickness of $4\frac{1}{2}$ inches over and above the warehouse scale. No differentiation was made in the byelaws or Building Acts for the quality of bricks used, or for the fact that the work was built in cement instead of in mortar. It would be quite ample for school purposes to adopt the same scale as for domestic buildings, taking care that the piers carrying girders and other special loads should be of the requisite strength. District surveyors also often required a floor with a carrying power of 2 cwt. per square foot, exclusive of the weight of the floor. This was an excessive amount for the purpose, and necessitated superfluous strength in all the girders and beams, and superfluously large piers to carry a theoretical load which would never exist in practice. The requirements of the London County Council and some other authorities with regard to the thickness of staircases, and to hardwood screens across landings, were equally excessive.

22. Local byelaws often insisted on the use of a dual system of drainage, for rainwater and soil drainage. Where the subsoil was absorbent, it was quite unnecessary to provide anything for the rainwater except sump-holes. In one case the borough council actually condemned a perfectly efficient system of rainwater, drains, and sumps on the ground that such an arrangement was insanitary. They took up and relaid the drains and claimed the cost from the managers of the school. The managers successfully appealed against this after an inquiry held by the Local Government Board.

23. Witness gave instances in which the interference of the district surveyor or the necessity of appealing against his directions, had led to delay and increased the cost of buildings. This was particularly the case in London, where the district surveyor had almost unlimited power, subject only to the tribunal of appeal, under the London Building Act of 1894, and in London there was the additional difficulty that what was passed by a surveyor in one district was sometimes rejected by a surveyor in another district. In country districts the same trouble occurred, though in a less degree.

24. The witness suggested that in all cases where plans had been approved by a Government Department, such as the Board of Education, they should be exempt from the byelaws, or, as an alternative, that plans which had been passed by the local education authority and the Board of Education should be exempt. The witness admitted that the second suggestion, if carried out, would create an opportunity for friction between the local education authority and the building authority where these bodies happened to be distinct, especially in the case of urban district councils in the provinces and the rural district

councils. For that reason he preferred the former alternative to be effected by legislation if necessary. In any case, the supervision of the district or local surveyor over the detail of building and the carrying out of the approved plans and specifications should be preserved.

IV.

MR. S. H. COWPER-COLES, F.S.I., Chairman of the Building Committee of the Breconshire Education Committee.

Actual Cost of Buildings as erected at present.

25. Witness had built a new school at Didmarton for the Duke of Beaufort at a cost of 15*l.* a head. This was in brickwork, for 72 children; the price was high owing to the expense of haulage from the railway. He had also built additions to other schools in Gloucestershire and Breconshire, and new council schools in Breconshire.

Novel Materials and Methods.

26. Witness did not consider that there would be any saving in cost obtained by the use of novel materials in country districts. He had used steel framework and reinforced concrete for building in Liverpool, and was satisfied that neither of these could be applied to school building in Wales, though steel-frame construction might be advantageously adopted for large town schools. In Wales good stone or brick was obtainable locally almost everywhere, while the cost of carriage was heavy.

27. He would not be prepared to build a school with walls of less than 14 inches in thickness, even with rough-cast on the outside. Rough-cast was not used in South Wales; it was expensive, and did not stand the weather.

Building Regulations.

28. Witness drew attention to certain points in the Board of Education's Regulations which might be modified with a view to economy. He thought that stone walls need not be 20 inches thick; 18 inches, or even, in certain cases, 15 or 16 inches, would be quite sufficient, as he had found in buildings other than schools. There would be a material saving if such a thinner wall could be accepted. Damp-proof courses in boundary walls were also unnecessary. And some of the rules, which were quite proper for towns, were inapplicable in the country; for instance, the requirement that doors should swing outwards was out of place in schools on the hills, where such doors would be very unsuitable; and ventilators were also not needed in their schools, which were built with large sash windows.

Mr. H. G. CROTHALL, Architect to the Middlesex Education Committee.

Causes of Increase in Cost of School Buildings.

29. Witness stated that schools erected by small School Boards in Middlesex, shortly before the Education Act of 1902 came into force, were often very costly, although no more suitable for their purpose, or better from an architectural point of view, than others now built for a much lower sum. Some of them, indeed, had proved full of defects and constantly required alterations and improvements. The high cost, amounting in some cases to 22*l.* per head, was partly due to pure extravagance in details; another reason was the want of special experience on the part of the architects. A small education authority, which had not enough work to keep an architect fully employed, would have to arrange a competition, and often an architect with little special knowledge of school-building got the appointment; school-building was really of a special class, and needed special experience on the architect's part to secure economy. The authority sometimes put forward unpractical ideas, and the architect would carry them out as best he could. Competitions were often arranged without due reference to the assessor, and an impossibly low limit of cost was fixed, with the result that it was entirely disregarded.

Actual Cost of Schools as erected at present.

30. The cost of school buildings erected by the Middlesex Education Committee now ranged from about 9*l.* 10*s.* to about 13*l.* 10*s.* per school place, according to the locality and the size of the school.

Possible Means of Economy under present Regulations.

31. Witness considered that the special study of school planning made by architects who were wholly employed by education authorities was resulting in economy and in the evolution of a better type of school. He referred to the "Pavilion" school, designed to secure through ventilation in each classroom; although this type could not be built quite so cheaply as a "central hall" school, the advantages were so great that it should be encouraged. He was aware that the relative cost in the Midlands seemed low—about 10*l.* per head—but this was due to the cheapness of building materials and labour in that district as compared with the London area. It was obviously impossible for a school with classrooms ranged along a corridor, and a detached hall, to be built so cheaply as one with a hall in the centre, between walls already provided for another purpose; in the "Pavilion" schools there was also the

extra cost of paving and wall-covering, and possibly glazing the long corridors. He was building schools of the "Pavilion" type with glazed corridors; the windows in the corridors were exactly opposite those in the classrooms, and there were dormers at the top for winter ventilation. These corridors would be warmed in winter.

32. In regard to dadoes, he considered a glazed brick surface unnecessary, and also found that such a surface caused condensation. He used a cement basis, finished in colour and polished; this cost about 3s. a yard, as compared with 13s. 6d. for tiles, or 18s. for glazed bricks, and did not cause any condensation. Where desirable this dado surface can be utilised for freearm drawing, but in that case does not want polishing.

Novel Materials and Methods.

33. Witness was of opinion that under existing conditions of building regulations and local acts and byelaws, it was not possible to take advantage of newer methods of construction, but that if these obstructions were removed, reinforced concrete might be used with advantage in some districts, where there was a dearth of good building material in the shape of brick or stone, but ballast or other suitable aggregate was available. There were, however, objections to the use of this material which required consideration. The average architect and average builder had no expert knowledge of ferro-concrete work, and an expert was needed to deal with it. Everything depended, in the erection of a ferro-concrete building, on the care and accuracy with which the structure was designed and executed, and skilled labour was absolutely essential. This could be obtained in Middlesex. The thinness of the walls necessitated a little extra heating power. The difficulty of condensation might be overcome by using a plaster with some porosity. Witness quoted, as an instance in which cost might have been reduced by the use of ferro-concrete, a school lately built by him at Yiewsley: this was a brick building for 320 children, together with cookery and manual training centres, and the finished cost was 4,734l., or 6d. per cubic foot, including drainage, paving, fencing, playgrounds, quantity surveyor's charges for bills of quantities, measuring variations, lithography, and all charges except cost of land. He had replanned the school as a ferro-concrete building, and found it could be built for 3,200l., thus saving about 33 per cent.* He used, for the outside walls, ferro-concrete piers, with a filling of concrete slabs: there was a double wall of 3-inch slabs with a 2-inch space between, rendered outside with cement: he had used a red brick plinth for the sake of colour

* A detailed comparison of the cost in brick and ferro-concrete is given in Appendix A.

only. The roof was a flat one of ferro-concrete. This material had many advantages, such as rapidity of construction, durability, much larger window area, and resistance to fire.

34. He stated that steel framed buildings with curtain walls of concrete slabs would be still cheaper, and suitable for country districts. At Northolt he had recently built a school for 216 scholars, which, owing to the dearth of building materials in the neighbourhood, had cost 3,112*l.* : he estimated that it would have been put up in steel and concrete slabs for 1,000*l.* The building could practically be sent down to a village ready for erection, and the cost of carriage would be much smaller than with brick construction. The method would be particularly suitable for rooms intended for instruction in cookery, laundrywork, and handicraft, or any building of a workshop nature. In country districts the cost of building cookery, laundry, and handicraft centres, as separate rooms, practically prohibited their erection with ordinary materials. He had overcome this difficulty, to some extent, by slightly enlarging an ordinary classroom, and providing a kitchen, sink, &c. at one end, which was cut off from the room by a sliding partition when the latter was required for ordinary class purposes.

Byelaws.

35. Witness submitted that the multiplicity of authorities whose approval had to be obtained before building could be commenced led to increased expenditure through the delay involved. In particular he complained of the operation of local byelaws, which were often loosely framed, and not adapted to modern conditions, and many of the officials entrusted with their interpretation were very narrow in their views, and were unable to grasp the fact that what was a suitable byelaw for an ordinary dwelling-house, had to be considerably modified to suit a building such as was needed to suit present-day requirements for educational purposes. He was very strongly of opinion that legislation should be promoted to exempt schools from byelaws and local Building Acts, as all byelaws and local Acts exempted all buildings erected for statutory purposes such as prisons, court-houses, dock and railway company buildings. He considered it only reasonable that school buildings, which are erected to meet the demands of legislation, should also be exempted from approval by a local authority. When the plans of a school had been passed by the Board of Education, it was quite unnecessary for the structural details to be reviewed under the byelaws. The drainage and water supply requirements were matters touching the public health of the district, and should be dealt with by the Local Government Board.

Colonel F. D. W. DRUMMOND, Agent to Earl Cawdor;
Chairman of Special Committee of the Land Agents' Society.

[*Note.*—The Council of the Land Agents' Society, on being approached by the Departmental Committee with a view to obtaining their evidence in regard to the cost of school buildings, appointed a special committee to collect and arrange such evidence. Colonel Drummond, as chairman of the special committee, presented a summary of the very considerable volume of material which had been obtained in response to a circular letter addressed to the members of the society.]

Causes of Increase of Cost of School Buildings.

36. There was a general expression of opinion on the part of the members of the Land Agents' Society that a great deal of money was now wasted on elaborate and useless ornamentation applied to school buildings, which resulted in a style of architecture at once extravagant and unsuitable to the surroundings. Witness expressed a hope that the Board of Education would exercise some restraint on local authorities in respect of the elevations of the buildings. Rectangular buildings with simple roofs would be far cheaper both to construct and to maintain than the elaborate elevations and gabled roofs so frequently erected.

37. Witness stated that in his experience the average expenditure per head on school buildings was about 8*l.* till 1890, but since then had risen to about 12*l.* to 14*l.* and even more, and he understood that such increases were general, and pointed to too much latitude being allowed to local and other authorities concerned. This increase was largely caused by the greater floor area now required, and the demands of the Board of Education for separate classrooms, cloakrooms and lavatories, hot-water heating, boundary walls (often unnecessary) and paving of playgrounds; other reasons were to be found in the more thorough drainage and ventilation systems now adopted; the latter, however, could not be classed as extravagances, since they were unquestionably desirable.

Possible Means of Economy under present Regulations.

38. Numerous instances had been supplied where unnecessary expense was incurred in school buildings by the use of materials which had to be brought from a distance, when local materials could have been obtained, and would have been more in keeping with the character of the surrounding buildings, as well as cheaper.

39. Other items in which the interests of economy were frequently neglected were boundary walls of playgrounds,

which were provided where a simple fence would serve just as well; the playgrounds were also often larger than the school needed; and flooring, which was done with wood blocks, when ordinary boards would be quite as good, clean, and durable, and considerably cheaper.

40. The injudicious choice of a site was also not infrequently a source of much unnecessary expense, and more supervision ought to be exercised by the Board of Education before a site was passed to see that it did not require excessive excavation or levelling, and was favourably situated for water supply.

Novel Materials and Methods.

41. Witness stated that the members of his society had not adopted novel building materials to any large extent; for the most part they still used brick or stone, and he did not think that, where brick was readily obtainable, there was any cheaper substitute for permanent work. But it ought to be permissible to erect schools in approved forms of concrete construction, such as were commonly used for naval and military buildings. He wished particularly to draw attention to the case of districts where the population was of a fluctuating character; good schools of a semi-permanent character could be built of wood and iron, and such buildings were used with excellent results in Norway and America. In view of the constant alterations in the requirements of the Board of Education, it was in his opinion a doubtful policy to erect structures designed for a long life, since they grew obsolete so rapidly; a cheaper and less permanent type of building might prove more satisfactory in the end.

Byelaws.

42. Witness was aware that the necessity of complying with local byelaws was a great obstacle in the way of adopting novel forms of construction; and he thought that his society would welcome legislation promoted to exempt school buildings, the plans of which had been approved by the Board of Education, from the necessity of complying with structural requirements of byelaws or local Building Acts.

VII.

Mr. H. H. DUNN, A.R.I.B.A., Consulting Architect to the Cambridgeshire Education Committee.

Causes of Increase in Cost of School Buildings.

43. Witness ascribed the increase in the cost of rural schools largely to the demand for better and more sanitary finish to schools internally, in such items, for instance, as glazed brick dados, wood block floors, folding partitions, plastered walls,

larger window area, ventilation, lavatory basins, and water supply. He regarded all these as very desirable in a permanent school.

Actual Cost of School Buildings.

44. Witness put in figures showing the cost of four rural schools recently erected or in course of erection in Cambridgeshire. These were as follows, taking first the cost of the school buildings and offices, and secondly the total cost including playground and boundary fences and teachers' houses.

	Buildings.			Total.	
	Accommodation.	Cost.	Per foot cube.	Cost.	Per foot cube.
		£	d.	£	d.
Wicken - -	120	1,081	5·6	1,852	6·6
Childerley - -	80	824	6·5	1,352	7·4
Meldreth - -	120	1,203	5·8	1,948	6·6
Odsey - -	80	838	6·1	1,389	6·9

If internal finish was omitted, schools could be built much more cheaply; he quoted a case of a small school built in Lincolnshire in 1899, with 14-inch brick walls and a joisted floor, without any glazed brick dado or plastering on the walls, which cost 4*l.* 9*s.* 6*d.* per place, and 4·2*d.* per foot cube.

Possible Economies under present Regulations.

45. As already stated, witness did not recommend any attempt to cheapen school buildings by reducing the quality of the internal finish. There would be a saving in the first cost if cement dados were provided instead of glazed brick; the extra cost of glazed brickwork was about 10*s.* a yard over stock brick and 7*s.* 6*d.* a yard over cement; but cement would require repainting at a cost of 9*d.* to 1*s.* a yard at least once in every four years, whereas glazed brick needed no repairs. His Committee had not gone into the question of comparative cost of cement and glazed brick, as they preferred the latter on hygienic grounds, not economical. He also thought that walls should be plastered above the dado line for the sake of hygiene.

He suggested that effective economy was best attained by the use of materials and methods of construction in general use in the locality of the proposed building, and by care in the selection of the most suitable and economical fittings.

Novel Materials and Methods.

46. Witness did not consider that reinforced concrete construction was at present practicable in rural districts, as local builders would not have the necessary plant; even if ballast

were readily obtainable on the spot, the cost and carriage of the requisite plant would swallow up any saving.

47. Witness had obtained alternative tenders for a drill-shed at Lincoln, on the one hand for ordinary 9-inch brick construction rough-cast in cement, on the other for a timber framed building with expanded metal lathing and cement rough-cast outside and a lining of Uralite sheets nailed on to battens inside. The tender for the former was 675*l.*, for the latter 640*l.*; and in view of the small difference in the prices, he accepted the tender for brick. Both tenders were from the same man, and witness did not think the builder quoted a specially low price for brick-work: in fact he would probably have preferred to have the contract for the timber building.

48. Witness thought that 9-inch walls with cement rough-cast outside would be quite satisfactory for small rural schools, and that some saving might be effected if such walls were allowed. The proportionate reduction in cost would vary at different schools according to the amount of walling and the situation of the buildings relatively to the brickyards; he estimated that, in the cases of the schools he had given, the saving by the adoption of 9-inch brickwork would have been at Wicken, 45*l.*—at Childerley, 25*l.*—at Meldreth, 52*l.*—and at Odsey, 38*l.* The adoption of 9-inch walls would necessitate extra heating power. 9-inch walls built in cement mortar with $\frac{3}{4}$ -inch hollow space and grouted with liquid cement every fourth course would result in a stronger wall and be still less costly.

49. He did not consider the possibility of building in steel framework with curtain walls of much value for rural schools, as the erection would entail special labour which is not readily obtainable in rural districts.

Effect of Building Regulations.

50. Witness did not complain of the building regulations generally, but thought that the cost of schools was sometimes increased by unnecessary criticism of details when plans were submitted to the Board of Education. He suggested that different standards should be applied to urban and to rural schools respectively.

VIII.

Mr. E. FISHER, Architect to the Berkshire Education Committee.

Actual Cost of Buildings as erected at present.

51. Witness stated that the average cost of the schools built in Berkshire by him for the Education Committee during the last five years was about 13*l.* per head. The expense was increased on account of the large size of the playgrounds.

Novel Materials and Methods.

52. Witness was convinced that there were several novel methods of building that would be constructively sound and as efficient as 14-inch brickwork, and would effect a considerable saving. The chief economy in their use would be in respect of walls and foundations; he quoted figures for two schools recently erected, where the total cost, including the building with heating and furniture, but not the playground, was 1,900*l.* and 3,800*l.* respectively, of which the amount for outside brickwork and foundations was 500*l.* and 900*l.* He thought he could make a saving of 30 per cent. on the walls and foundations, or 10 per cent. on the total cost.

53. He had built a cookery and handicraft centre in brick at Abingdon for 1,100*l.*, including 200*l.* for fittings. He had made plans providing the same accommodation for a similar centre at Bracknell, substituting for 14-inch brick walls thin hollow walls of two thicknesses of bricks on edge, reinforced with steel wire mesh, and a 3-inch space between: the weight was taken on piers of solid 9-inch brickwork reinforced; thus the wall was 9 inches thick throughout. The estimate for this building was 700*l.*, including 200*l.* for fittings, thus showing a saving of about 45 per cent. on the construction.* The difference in the cost of bricks at Abingdon and at Bracknell was practically negligible; it was somewhat higher at Abingdon, but the extra cost on the whole building would not be more than 5*l.* The saving arising from the use of reinforced brick would be proportionately greater in a centre of this kind than in an ordinary school building, as the proportion of shell was larger.

54. Witness had obtained alternative estimates for the erection of the building at Bracknell with steel piers and Frazzi filling, and found that this was rather more expensive than reinforced brickwork. In other cases, however, the steel and Frazzi construction might prove more economical; bricks were cheap at Bracknell, but, on the chalk hills, where there were no local materials, he would expect Frazzi to have the advantage in point of cost. He also thought the construction in brick was simpler; though for the erection of reinforced brick specially skilled labour was necessary, and the least vibration prevented the wall setting properly.

55. Timber construction would, in witness's opinion, be satisfactory for schools, especially if they were only to be of a semi-permanent nature; and he questioned whether school buildings were not now designed for too long a life. A wooden building, weatherboarded outside, with a tiled roof, would certainly last for 20 years, and it would be much easier to alter than a brick building. There would be no serious risk in case of fire in a small one-storey school so constructed, as every room could be emptied in a few seconds.

* Details of the comparative cost in these two cases are given in Appendix B.

56. Witness would not be prepared to accept 9-inch brick walls, rough-cast outside, as sufficient for school buildings unless piers, either of 14-inch brick, or 9-inch brick reinforced, were provided to carry the roof trusses.

Byelaws.

57. There had been no difficulty about getting the plans for the Bracknell Centre passed under the local byelaws, and generally witness had found the local surveyors in Berkshire reasonable in their interpretation of byelaws; but he thought that it would be very desirable that, in all cases where the Board of Education had passed the plans for a school building, these plans should be exempted from the operation of the byelaws as regards structural details. Such an exemption, if accompanied by a relaxation of the Building Regulations of the Board of Education, would encourage local authorities to make experiments in the direction of introducing more economical methods of building.

IX.

Mr. T. ERNEST HAWKINS; of 109, Victoria Street.

Novel Materials and Methods.

58. Witness said that he had constructed schools, permanent and temporary, in all parts of the country, but was particularly a specialist with regard to the construction of temporary schools of wood and iron, and had been advocating for several years the utility of semi-permanent schools constructed of reinforced concrete slabs. He quoted the buildings erected by his firm at the Franco-British Exhibition. These were not put up as permanent structures, since the Exhibition was only expected to stand for three years; but the principle could easily be adapted to give a much longer life. The majority of the buildings were of one storey, but there were some of two or three storeys. The whole of the weight was carried on steel framework, with curtain walls of 3-inch concrete slabs. An intermediate reinforcement of horizontal bars had to be used where the wall ran over a long span. The walls were plastered outside with lime plaster; for a permanent building he would use cement rough-cast. For weathering, witness had made experiments with a bituminous coating covered with fine grit instead of rough-cast, as he had found the walls at the Exhibition rather porous. He had not, however, used the bitumen in actual building, though he had specimen slabs at his works which had stood exposure for four years quite well. Reinforced concrete slab buildings of this kind were most suitable for districts where it was impossible to gauge the possible requirements of the locality a few years ahead, and

where more expensive buildings, if supplied, were often in a few years' time quite unsuitable for the altered conditions of the district.

59. Witness considered that a satisfactory school building could be constructed on this principle with 3-inch walls, or 4-inch finished, for a single storey. Walls of this description were just as rigid, just as warm, and almost as lasting as a brick structure. This kind of structure would have been adopted by several local authorities if loans could be obtained on the same conditions as for brick structures. He had built temporary schools on this principle at Rotherham and Oldham.

60. As to the life of these buildings, there was no reason to think that it was not equal to that of a brick building; he would be prepared to guarantee them for 40 years. Their great recommendation was their extreme cheapness; the cost worked out to under 4*l.* per head. Such buildings were accepted by insurance offices as an even safer risk than brick buildings, and, their durability being equal, there was no reason why loans should not be granted for them on the same terms as for brick.

61. Witness handed in a plan of a school for 300, the actual cost being 850*l.*, or 4½*d.* per cube foot. As regards other materials, witness said that substantial wood and iron temporary buildings could be supplied at from 35*s.* to 45*s.* per head, conforming to the regulations of the Board as to cubic and superficial space. These buildings were made up in sections, so that they could be taken down and used again.

[The following addendum to his evidence was subsequently supplied by Mr. Hawkins]:—

62. The relative cost, for walls of school buildings, of reinforced concrete slabs and of brickwork, as ascertained from comparison with schools erected for the Middlesex and Surrey Education Committees, is as follows:—

Concrete slab walling, finished (including plastering), with reinforced steel bars, 6*s.* 6*d.* per yard super.

Fourteen-inch brickwork (including facing and inside plastering), 13*s.* per yard super.

There is a further saving of five per cent. in the foundations of the former, which, distributed over the whole of the brickwork, would represent a total saving of 10 per cent. on the total brickwork cost. The walls in concrete slab being 4 inches thick, instead of 14 inches, an increase of five per cent. is obtained in the cubical contents of the buildings.

After examining the cost of various permanent schools actually erected in brickwork, I find a total saving of approximately 22 per cent. on the gross total cost of the buildings would have been effected by the use of reinforced concrete slab walls; while for semi-permanent works the saving could be made at least 33 per cent.

X.

Mr. J. HUTCHINGS, A.R.I.B.A., Architect to the Staffordshire Education Committee since August 1903.

Causes of Increase of Cost of School Buildings.

63. Witness was of opinion that the increased cost of public elementary schools was due mainly, if not entirely, to more stringent regulations and to the higher standard now required by the Board of Education: he instanced the following points:—

- (1) The large amount of floor space for infants (*e.g.*, marching space) now required by the Board of Education, nominally fixed at 9 square feet, but which often works out at more than 11 square feet when all the conditions have been fulfilled.
- (2) The importance attached to physical exercises, and the necessity of paving some portion of each playground, so that these exercises may be conducted out of doors whenever possible.
- (3) The provision of adequate means of ventilation, having regard to the crowding of children into comparatively small rooms.
- (4) The increase in heating, due to the extra ventilation. Whilst at the time the Education Act, 1902, came into force an average of 10 square feet of direct heating surface per 1,000 cubic feet of contents was considered sufficient in low-pressure hot-water heating, the Staffordshire Education Committee soon found it necessary to increase the heating surface to 18 square feet, and they now employ a constant of 25 square feet (average) direct heating surface per 1,000 cubic feet of contents. This increase from 10 to 25 square feet represents an extra cost of about eight shillings per child, irrespective of maintenance.
- (5) The requirements of the Local Government Board with reference to (a) the provision of a water supply, (b) the construction of earth-closets, and (c) arrangements for the disposal of sewage. These specially affected small rural schools, where a well sometimes had to be sunk. The type of earth-closet adopted was expensive, but satisfactory.

He did not question the reasonableness of these requirements: they were the result of progress and greater efficiency, and might be regarded as inevitable. He did not think that materials or labour accounted for the principal increase in cost.

Actual Cost of Buildings as erected at present.

64. Witness submitted a list of schools recently built under his committee, showing a cost per head for building, including

heating, lighting, boundary walls, fencing, offices, and out-buildings, varying between 8*l.* 1*s.* 0½*d.* and 13*l.* 11*s.*, and a total cost per head, including site, furniture, and all contingent expenses, varying between 10*l.* 4*s.* 5½*d.* and 17*l.* 19*s.* 9*d.** The cost per foot cube ranged from 3½*d.* to 5*d.*, the latter figure being for small schools remote from railways: the average was about 4½*d.* for ordinary brick construction. He said that Staffordshire was a cheap place for building materials other than timber, and submitted a schedule showing the prices prevailing in different parts of the county.*

The committee were now building schools of the pavilion type: the total cost per head in three of these was 10*l.* 16*s.* 1*d.*, 10*l.* 19*s.* 1*d.*, and 10*l.* 9*s.* 9½*d.* per head respectively. Schools of this type required from 5 to 10 per cent. more heating surface than those of the ordinary plan with cross ventilation, and he was not sure than the maximum had been reached. An instance of the high cost involved in country schools was at Anslow, where they had to drive a well 90 feet deep, costing nearly 70*l.*, to supply a school of 148 children.

Possible Means of Economy under present Regulations.

65. Witness did not think that there was much possibility of reducing the cost of erection of buildings; he considered that they were now building very cheaply; the estimates were certainly low, from 5 to 10 per cent. less than those of two years ago.

66. He suggested that a saving might be effected if sites could more easily be obtained at market value. Some rapid and inexpensive process should be devised to enable a public body to acquire land at a reasonable valuation. The purchase of mines, often necessary in Staffordshire, materially increased the cost of a site. His committee had sometimes to take an inferior site, because of the expense of a more suitable one. They had not tried compulsory purchase, as they understood this involved heavy legal charges and prolonged delay.

Novel Materials and Methods.

67. Witness had had practically no experience of building with unusual materials. He had obtained estimates for special foundations in a district which had been badly mined, and there were cracks across the site on which he had to build, but finally had used a reinforced concrete foundation of his own devising. This consisted of a footing of concrete formed by blocks 3 feet square in section placed continuously under the walls and reinforced with wrought-iron rods tied at the angles.

68. He thought authorities should be free to adopt reinforced concrete, terra-cotta blocks, or any other suitable and durable materials; though in Staffordshire, at all events, the use of these

* See Appendix C.

materials would not effect much saving as against brick. If main walls were reduced in thickness, to 9-inch brick or 6-inch concrete, more heating surface would be required. A thin hollow wall would be as effective for warmth as a 14-inch brick one, if it could be prevented from cracking. He had not worked out the comparative cost of these materials. Reinforced concrete was employed for floors and roofs, but he did not find a great saving in expense from this: it had the advantage as against timber of being more fire-resisting.

Building Regulations.

69. Witness suggested that the Building Regulations should be modified so as to admit of experiments with novel materials; for instance, pillars of steel or reinforced concrete, with thin curtain walls between, might be tried. Loans of 30 years should be sanctioned for all kinds of materials and methods of construction which had proved satisfactory and durable.

XI.

Mr. W. JACQUES, A.R.I.B.A., Architect to the West Ham Education Committee; of 2, Fen Court, E.C.

Causes of Increase of Cost of School Buildings.

70. Witness stated that there had been a gradual increase in the cost of school buildings. In the early seventies he had erected schools in West Ham at from 6*l.* to 6*l.* 10*s.* per head, whereas the present rate was about 15*l.* This increase was due mainly to improvements in planning; modern schools were better warmed and lighted, and provided with large halls and playgrounds, but these improvements were necessarily expensive.

Actual Cost of Buildings as erected at present.

71. Tenders had recently been obtained for a secondary school at Leytonstone, which came out at 6*d.* per foot cube, including the fencing of a playground of two and a half acres, but exclusive of heating and electric fittings. The two elementary schools most recently completed cost about 7*d.* per foot cube, including playgrounds. At present schools were being built more cheaply than at any time during the last 20 years, as building prices, especially for brickwork, were low; he had recently had tenders for brickwork at 11*l.* 10*s.* a rod, whereas a few years ago he had paid 16*l.*, or, for small works, as much as 20*l.*; the bricklayer's bill was about one-third of the total cost of a school.

Possible Means of Economy under present Re-

72. Witness said that his committee preferred pitch-pine matchboarding to glazed brick for school rooms, partly on account of the economy in cost, partly of warmth; varnished matchboarding cost 5*d.* per square foot and salt-glazed brickwork would add from 9*d.* to 1*s.* per foot to the expense; as regards maintenance, the matchboard had to be revarnished, at a cost of 7*d.* per square foot every four or five years, though in a clean neighbourhood it might last for seven years. He found the matchboarding objectionable from the point of view of cleanliness for school halls, though he would not recommend it for narrow corridors.

73. In South West Ham, where the subsoil was very bad, the expense of foundations was serious. He had effected a considerable economy in the case of a school by floating it on a raft of reinforced concrete. He would have had to go down 15 feet to get to the bottom to carry down concrete to that depth would have cost the cost of his raft was 425*l.* An additional advantage of a reinforced foundation was that it enabled him to carry the whole foundation to carry the walls, and so reduced the pressure on the soil to less than 10 cwt. to the square foot.

Novel Materials and Methods.

74. Witness considered that steel framework for school walls might be allowed for school buildings. If 1,000 children were planned on this method, with 14-inch brick on the exterior, and sound-proof partition of thick brick walls, he estimated that there would be a saving of from 5 to 7½ per cent. on the total cost. With two thicknesses of 4½-inch brick and a space between them would be a reduction of about 20 per cent. in the cost of external walls as compared with a 14-inch brick filling. Instead of brick, a double filling of slabs of concrete, or of similar material, might be used. A hollow wall was objectionable for warmth, unless there was a solid wall at least 4 inches thick. There would, in addition to the saving on the external and internal walls, be considerable economy in the foundations from the adoption of this method of construction. The weight of the building would be reduced, and it would be necessary to have so wide or strong a bearing surface.

75. Ferro-concrete construction would not, in his opinion, be of any advantage as regards expense for a one storey; it might be cheaper than brick for a two storey school. He did not, however, consider ferro-concrete suitable for the external walls of schools, unless measures to prevent hollow air space in the walls, were adopted to prevent condensation of damp, condensation on the interior faces, and loss of heat.

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walls might be rough-cast on the outside, but he did not think this suitable for London or large towns, as the rough-cast would very soon be black. Ferro-concrete or steel framework construction could not safely be used except under the advice and supervision of properly qualified architects or engineers. Further, he hesitated to recommend the use of ferro-concrete, or concrete in any form, for the exterior of schools, on æsthetic grounds; he had never yet seen a concrete building which was satisfactory in appearance, and, considering the importance of schools as public buildings in most localities, he thought nothing should be done to detract from their architectural merits.

76. Witness did not recommend solid 9-inch brick external walls for rooms that were to be used for teaching purposes. If rough-cast, such a wall might be made impervious to damp, but not as warm as a 14-inch wall, and there was the general objection to the use of rough-cast in towns already given. He thought, however, that a hollow wall consisting of a $4\frac{1}{2}$ -inch outer and $4\frac{1}{2}$ -inch inner wall, with a $2\frac{1}{2}$ -inch space between, tied with galvanised iron ties, would be quite suitable for small or one-storey schools; it would be as impervious to damp and to changes of temperature as a wall 14 inches thick, and from its wider base would be more stable than a 9-inch solid wall. He had built a small mission church about 1876 with hollow walls of two thicknesses of brick on edge with a 2-inch space, tied with iron ties, having piers opposite the roof principals, and cemented outside; and the building was still quite sound. The cost of this church was about $2\frac{1}{2}d.$ per cube foot, with brickwork at about 9l. 10s. per rod.

Byelaws.

77. Witness thought that it was essential in order to adopt these methods of construction that schools should be exempted from the operation of the building byelaws so far as related to the structure. They were at present classed with warehouses; but, in small schools of one floor especially, compliance with the regulations for domestic buildings would be sufficient to secure stability and permanence. As an instance of the way in which the byelaws prevented economy, he pointed out that, if he put in the foundations of a building by forming piers and carrying a reinforced beam from pier to pier, he would still be required to make these beams of the full width prescribed by the byelaws for concrete footings under walls. The West Ham byelaws were not so stringent as some; but in many districts there were wholly unnecessary regulations to be met. Most byelaws were really out of date, so far as related to the structural part of buildings.

Possible Means of Economy under present Regulations.

72. Witness said that his committee preferred varnished pitch-pine matchboarding to glazed brick for dadoes in classrooms, partly on account of the economy in cost, partly on grounds of warmth; varnished matchboarding cost 5*d.* per square foot, and salt-glazed brickwork would add from 9*d.* to 1*s.* per square foot to the expense; as regards maintenance, the matchboarding had to be revarnished, at a cost of 7*d.* per square yard, every four or five years, though in a clean neighbourhood it might last for seven years. He found the matchboarding quite satisfactory from the point of view of cleanliness for classrooms and halls, though he would not recommend it for narrow corridors.

73. In South West Ham, where the subsoil was generally very bad, the expense of foundations was serious, and witness had effected a considerable economy in the case of a school in course of erection by floating it on a raft of reinforced concrete. He would have had to go down 15 feet to get to the ballast, and to carry down concrete to that depth would have cost 2,500*l.*; the cost of his raft was 425*l.* An additional advantage of the reinforced foundation was that it enabled him to utilise the whole foundation to carry the walls, and so to reduce the pressure on the soil to less than 10 cwt. to the square foot.

Novel Materials and Methods.

74. Witness considered that steel framework with curtain walls might be allowed for school buildings. If a school for 1,000 children were planned on this method, with curtain walls of 14-inch brick on the exterior, and sound-proof partitions in lieu of thick brick walls, he estimated that there would be a saving of from 5 to 7½ per cent. on the total cost. With a filling of two thicknesses of 4½-inch brick and a space between, there would be a reduction of about 20 per cent. in the cost of the external walls as compared with a 14-inch brick filling. Instead of brick, a double filling of slabs of concrete, or Frazzi, or similar material, might be used. A hollow wall was necessary for warmth, unless there was a solid wall at least 14 inches thick. There would, in addition to the saving on the external and internal walls, be considerable economy in regard to foundations from the adoption of this method of construction: the weight of the building would be reduced, and it would not be necessary to have so wide or strong a bearing surface.

75. Ferro-concrete construction would not, in witness's opinion, be of any advantage as regards expense for a school of one storey; it might be cheaper than brick for a two or three storey school. He did not, however, consider ferro-concrete suitable for the external walls of schools, unless means, such as a hollow air space in the walls, were adopted to prevent penetration of damp, condensation on the interior faces, and loss of heat; the

walls might be rough-cast on the outside, but he did not think this suitable for London or large towns, as the rough-cast would very soon be black. Ferro-concrete or steel framework construction could not safely be used except under the advice and supervision of properly qualified architects or engineers. Further, he hesitated to recommend the use of ferro-concrete, or concrete in any form, for the exterior of schools, on æsthetic grounds; he had never yet seen a concrete building which was satisfactory in appearance, and, considering the importance of schools as public buildings in most localities, he thought nothing should be done to detract from their architectural merits.

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XII.

Mr. J. G. LEGGE, Director of Education, Liverpool.

Building Regulations.

78. Witness suggested that the building regulations of the Board might be relaxed in the following particulars :—

1. Where an infants' section or department has attached to it a central hall, providing floor space of not less than 4 square feet for each scholar in the section or department, some allowance should be made in respect of the places for which the department is recognised.

2. Where a fully equipped handicraft or domestic centre is attached to a school, is utilised full-time, and, therefore, will during school hours, at all times, contain at least 18 or 20 scholars, to that extent the Board of Education should allow such centre or room to be included in the ordinary school accommodation. It is urged in particular that there can be no possible objection to such a course where, during the last year of a child's life, the instruction is given half-time in a classroom, and half-time in a workshop or domestic centre.

3. It is suggested that more elasticity might be permitted under regulations governing the space required in rooms used for handicraft, cookery, laundry, &c. In schools which lay stress on this side of a child's training it is submitted that less accommodation will be required per head than in ordinary cases. Elasticity is further required in the regulations to admit of full use being made of cookery centres which were built to meet the Board's old regulations, and now, while unnecessarily large for one class, are not quite big enough for two.

4. Now that smaller classrooms are being provided, regulations as to height of rooms might be reduced. Where cross ventilation is provided with either the open air on both sides or on one a well-ventilated corridor, a room 13 feet high has no real advantage over one 11 feet high.

5. It is suggested that the Board's requirements as to playground accommodation are unnecessarily high ; while the 30 feet basis will not provide enough space for games in the nature of field sports, it is needlessly large for purposes of aeration.

Byelaws.

79. Witness stated that the requirements of the Liverpool byelaws went beyond the regulations of the Board, which provided for reasonable means of safety. The building surveyor in Liverpool was inclined to insist that all schools should be of fireproof construction, which the advisers of his committee considered quite unnecessary.

XIII.

Mr. H. LITTLER, Architect to the Lancashire County Council and Education Committee.

Actual Cost of Buildings as erected at present.

80. Witness handed in a summary giving a general description and particulars of the cost of schools erected by his Education Committee.* The average cost of buildings of every description was 11*l.* 15*s.* 8*d.* per scholar; that of ordinary brick schools, mostly of the central hall type, was 10*l.* 11*s.*; that of similar schools, faced externally with stone, was 11*l.* 14*s.* 3*d.*; while schools with additional accommodation for teaching special subjects cost from 13*l.* to 14*l.* 17*s.* 3*d.* He stated that in his opinion a two-storey building would usually work out slightly cheaper than a single-storey one, but the difference would not be more than 5 per cent., and even this would be governed by conditions of site and tendering.

Possible Means of Economy under present Regulations.

81. Witness stated that he could build schools somewhat cheaper in the first instance, but that he did not believe that it was possible to reduce materially the cost of the buildings which he was erecting without incurring increased cost in upkeep. As regards walls, there would be no real economy in omitting the facing of pressed bricks, which he regularly used. The cost of pressed bricks was from 1*s.* 6*d.* to 2*s.* a yard extra over common, but, if well built, a wall faced with these bricks ought not to need repointing in less than 25 or 30 years. The Lancashire common brick, on the other hand, would not, as a rule, stand weather, and if the walls were not faced with pressed bricks they would need considerable attention and repair in the course of a few years. For roofing he had not yet found any substitute for slates which had been decisively proved satisfactory, though some of the new types of asbestos slating seemed to give fair results, and, being lighter, would allow of saving in roof timbers if used. He considered glazed brick or tile dadoes necessary and economical; cement or wood dadoes required repainting every two years, and in 10 or 12 years the extra cost of glazed brick over cement would be more than saved; even the best cement could not be washed without damage to the surface. There was practically no external adornment in Lancashire schools, except in places where a specially good type of building was demanded. Fronting the roadways, it was customary to provide a low boundary wall with a stone coping and iron rail on top of same. Something might be saved by using unclimbable railings, at a cost of 7*s.* or 8*s.* a yard, instead of the boundary walls, which cost 35*s.* to 2*l.* a yard, but generally the District

* See Appendix D.

Committees prefer the latter, in spite of the extra expense. He found that most small extravagances (if they can be called extravagances) in his buildings were due to local pride of the district committees, who were always desirous that the schools which they erected should be at least as "up-to-date" and as good as those erected by their neighbours.

Novel Materials and Methods.

82. Witness had had no experience of novel methods of construction in school building. He had obtained tenders for the erection of a school in reinforced concrete, and found the price quoted was 7s. a yard; this was for walls 6 inches thick. To this cost would have to be added the finish inside and out, and it would be necessary to use two coats of best cement rough-cast outside. The result would be dearer than a brick wall. A 16-inch brick wall could be put up in Lancashire for 6s. 4d. a yard, with 2s. a yard extra for pressed brick facing.

83. He had not gone into the question of steel frame buildings, but was of opinion that no great economy could be effected by their adoption, as the facing slabs alone would cost 4s. a yard. Such buildings would require extra heating, though he admitted that, given heating by hot water, the thickness of the walls was, in view of the large space occupied by glass, not the sole determining factor.

84. He thought that 11-inch cavity walls might be used in some cases, especially if reinforced with wire netting; they would turn the wet better than a 9-inch solid wall, though the latter was constructionally stronger and also transmitted sound less. In order to ensure the provision of a thoroughly dry building, it was necessary to form cavities in either brick or stone walls, and even then it was necessary that the brickwork should be carefully set. He had known damp penetrate even through a 16-inch brick wall. The Lancashire pressed bricks are almost impervious, and if the joints and beds are not carefully flushed and filled with mortar, and water is allowed to get into the panels of the bricks, it is fatal to good brickwork. A 9-inch brick wall faced with rough-cast costs about 4s. a yard for brickwork and 2s. 4d. for rough-cast, giving a saving of about 2s. as against a 16-inch brick wall faced with pressed bricks.

XIV.

Mr. H. CARTER PEGG, F.R.I.B.A.; of 35, Parliament Street, S.W.

Causes of Increase of Cost of School Buildings.

85. Witness stated that in his opinion the cost of building schools, which had risen materially in late years, was likely to rise further. The reasons for this were (1) the tendency to

teach children in smaller classes; (2) the greater attention paid to school hygiene, which demanded more cubic space per child and more frequent change of air in the classrooms; (3) the movement in favour of detached halls, which would render more corridors necessary than was the case where the hall was central and fulfilled the functions of a corridor.

Actual Cost of Buildings as erected at present.

86. Witness submitted a schedule showing the total cost of the six schools erected from his plans for the Croydon Local Education Authority in the last ten years, with details as to the accommodation, cubic space, and cost per place and per cube foot.* The average cost of these schools per place was 13*l.* 8*s.* These schools were all in two blocks—a two-storey block for boys and girls, and a single-storey one for infants—with one exception, in which the whole school was in one two-storey block and arranged for mixed and infants.

Possible Means of Economy under present Regulations.

87. Witness considered that in many schools there was great extravagance in design, construction, and materials. He drew attention to the fact that the cost of schools in London was almost 50 per cent. more than in Croydon, although the building rates were much the same. Part of Croydon was in the London Trade Union area, and at half the schools in Croydon which he cited the London rate of wages were paid; while materials were, if anything, dearer in Croydon, as they chiefly came from the North and had to cross London. He analysed the excess of cost in London over Croydon under the following heads:—(1) 20 to 30 per cent. due to waste of space in planning; (2) 10 to 20 per cent. to more irksome conditions of tendering; (3) 50 per cent. to more costly systems of construction. He illustrated this by a comparison between secondary schools in Croydon and London (Furzedown). The differences under separate items of construction were: For stonework, Croydon, 2*l.* 2*s.* per place, against London, 9*l.*; for preliminaries of contract, excavator, and bricklayer, 16*l.* 6*s.* against 26*l.* 6*s.*; for plumbing, 1*l.* 6*s.* against 3*l.* 2*s.*; for carpentry and joinery, 6*l.* 10*s.* against 13*l.* 18*s.*; for smith and founder, 5*l.* against 4*l.* 12*s.*, the difference in total being Croydon 30*l.* 8*s.* against London 64*l.* 10*s.* The extra cost in London was largely due to over-elaboration of detail, not to superior material; for instance, at Croydon the woodwork was American whitewood, wax-polished; in London it was only painted deal; at Croydon the floors of classrooms are of polished pitch-pine blocks; in London, ordinary deal boards.

88. He thought a two-storey building somewhat cheaper than a single-storey one. The figures at Winterbourne Road, where

* See Appendix E.

he had built in two blocks, one of two storeys and the other of one, showed, on a cost of 5'65*d.* per cube foot, a cost per place of 11*l.* 3*s.* for the two-storey block and of 12*l.* 12*s.* 5*d.* for the single-storey one. On the other hand, a three-storey building was comparatively dearer, as additional expenses, such as extra staircases, were involved, which more than counterbalanced any saving on roof and foundations.

Novel Materials and Methods.

89. Witness had continuously had under consideration the question of other methods of construction and materials, with a view of reducing the cost of buildings; but his experience, which was extensive, had not showed him that any method or materials at present known would enable permanent schools to be erected more cheaply than in ordinary brick construction. He had used ferro-concrete for floors, which gave a saving of 25 to 30 per cent. on the cost of the flooring, but this was comparatively a small item; he quoted a case where by this method about 150*l.* or 200*l.* was saved on a contract of 15,600*l.* He always built his schools with hollow walls and had never experienced any difficulty with damp.

XV.

Mr. J. J. REDHOUSE, Builder; of Stotfold, near Baldock, Herts.

Actual Cost of Building as erected at present.

90. Witness submitted details of the cost of three schools—Hatfield Boys' School, Arlesey, and Biggleswade,—the two former erected by him and the third by another builder.*

Possible Means of Economy under present Regulations.

91. Witness considered that the cost of schools could be largely reduced, without the use of any new materials, if architects would eliminate unnecessary ornament and had more practical training. He drew special attention to the low cost of Hatfield School, which was designed by Lord Salisbury's estate architect and built by witness on a contract obtained after open competition: the economy was not effected by any peculiarity in the plan or method of construction, but by regard to details. The walls were of local handmade bricks, and some saving could actually have been effected on these by the use of Peterborough bricks. There were no pressed facing bricks, nor internal glazed brick dados. The walls were finished in Robinson's cement and distempered, and they had needed no repair in five years.

* See Appendix F.

92. He suggested that if architects considered carefully what was the cheapest form of material to be obtained at any particular place and time, there could be much saving. For instance, architects would specify sizes of timbers which had to be specially cut out of baulk, instead of using stock sizes, which would be 25 per cent. cheaper; or they insisted on slates of Countess size, when smaller sizes could be had at a much lower rate and were equally good. He had known quite unnecessary expense incurred through the use of patent wood-block flooring: as a general rule, he would eliminate patented articles when others equal in every respect could be obtained at a lower price. As an example of wasteful expenditure through neglect of local materials, he quoted a case of a school in his district which had been faced with red bricks brought from a distance, when good white facing bricks were manufactured in the vicinity.

93. He considered that a great saving could be made by carrying up the walls to the top of windows, instead of breaking through the eaves and forming dormers over the windows as often done. The cost of the additional brickwork between the windows would be less than the work entailed in breaking into the roof with dormers, and the other trades in connection.

Novel Materials and Methods.

94. Witness had had a good deal of experience of concrete work, and had built farm buildings in reinforced concrete; but he did not think this form of construction of much practical value for school or domestic work in the country. He considered that 9-inch brickwork with cement rough-cast facing would not be much cheaper than 14-inch brickwork in his district, though it might be so where bricks were dearer: the cost of the cement rough-cast would swallow up all the saving on bricks in schools, where the amount of wall space was comparatively small on account of the size of the windows.

XVI.

Mr. T. TALIESIN REES, F.R.I.B.A., Architect to the
Birkenhead Education Committee; of May Buildings,
North John Street, Liverpool.

Actual Cost of Buildings as erected at present.

95. Witness submitted details as to the cost per head and per foot cube of three schools recently erected by him for the Birkenhead Education Committee.*

* See Appendix G.

Possible Means of Economy under present Regulations.

96. Witness had found that some saving might be effected by watching carefully during building operations for any opportunity of economy. At Woodchurch Road the actual cost had been 150*l.* below contract, and at Hemingford Street the reduction would be nearly 500*l.* In general, he considered that economy could be consulted by using common bricks for facing instead of pressed bricks, and that for glazed brickwork seconds were quite good enough.

Novel Materials and Methods.

97. Witness had investigated the possibility of using ferro-concrete for school buildings, and had prepared plans for a school to be constructed on this system. These plans were an exact facsimile in area of the latest school he had designed in brick for the Birkenhead Education Committee, and gave accommodation for 780 children in 14 classrooms on two storeys. He found that the cost of such a building complete with internal fittings, lighting and heating, but exclusive of playgrounds, boundary walls, and outside offices, was in ferro-concrete 8,639*l.* and in brick 7,230*l.*; or taking the price per foot cube, 6*d.* and 5*d.* He had designed the school so that it could be erected as cheaply as possible in ferro-concrete, with similar rooms on both wings. His conclusion was that a school building was too small for any advantage to be derived in point of cost from the use of ferro-concrete.

98. Witness had not gone into the question of building with a steel framework and curtain walls of slabs. Such buildings would not be permissible under the Birkenhead byelaws, which were very strict. He did not think, however, that there would be much saving from the use of this form of construction for a two-storey school building.

Byelaws.

99. Witness considered that the local building byelaws in Birkenhead increased the cost of building schools and were unnecessarily restrictive. In particular, he drew attention to the requirements of the byelaws as to the strength of fireproof floors. Schools were classed with warehouses, and floors had to be constructed to take a load of $1\frac{3}{4}$ cwts. per foot super in classrooms and 2 cwts. in central halls: these loads could safely be reduced by $\frac{1}{2}$ cwt. in each case. The latest requirement proposed in the London Building Acts was for only 100 lbs. per square foot in a building intended for a school. Again, the byelaws required cloakrooms to be 8 feet 6 inches in height from floor to ceiling, though the Board of Education would pass a foot less; if the greater height were insisted upon, it would prevent the planning of a cloakroom on the mezzanine floor of a two-storey school, unless the ground floor were of

excessive height. He had always felt that schools, the plans of which had been approved by the Board of Education, should be exempt from the local byelaws as regards construction, and would suggest that legislation should be promoted to effect such exemption; details as to drainage and the like should, however, still be subject to the approval of the local authorities. He did not think that there would be opposition to such legislation.

XVII.

Dr. GEORGE REID, County Medical Officer and
School Medical Officer, Staffordshire.

Possible Means of Economy under present Regulations.

100. Witness considered that the pavilion type of school which had been adopted in Staffordshire was much more economical than the ordinary type, as well as greatly preferable from a hygienic point of view. It was designed without central halls or corridors, and the classrooms communicated with each other by verandahs. In regard to ventilation he thought this type, allowing as it did of cross window ventilation, was the only permissible one. Experience had shown that the results were excellent; the air of the rooms could be changed six times an hour without draught. The extra ventilation made additional heating surface necessary, but the cost of this was not excessive; the mean heating surface (low pressure) now provided in these schools was 25 feet per 1,000 cubic feet, and no fireplaces were put except in infants' class-rooms. In the case of large schools, a single detached hall was provided to serve all departments, instead of a central hall for each department; this had proved quite satisfactory educationally and was the chief cause of the reduction in cost.

101. Glazed brick dadoes were not, in witness's opinion, essential for hygienic purposes. He thought the only advantage of glazed brick over painted cement was in durability and cost of maintenance; so far as health was concerned, he would be quite satisfied with a lime-washed brick wall with painted cement dado. The important point was that the walls should be regularly cleaned and rewashed, and simple spray apparatus was now available for enabling this to be done expeditiously and economically. In any case, the use of glazed brick was often pushed to absurd lengths, as for instance in the facing of manholes.

Novel Materials and Methods.

102. Witness found objections on grounds of health to any method of construction which involved the introduction of thinner walls than 14-inch brick, unless possibly hollow $4\frac{1}{2}$ -inch walls. He pointed out that the governing considerations were heating and condensation. As regards the former, the comfort

of a room did not entirely depend on the actual temperature of the air recorded by a thermometer, but greatly on the rate of abstraction of heat from the surface of the body, which was largely determined by the temperature of the walls. If the walls of a room were cold, the room would feel chilly, even though the air in it might be warm; with a thin wall, which cooled quickly, there would be great difficulties in ventilation, as the rooms could not be flushed with fresh air in the intervals, on account of the poor capacity of the walls for storing heat. He admitted that a considerable area of the school walls consisted of glass, which increased the rate of abstraction of heat, but considered that, even with large window-spaces, there was still a sufficient amount of brickwork to contribute a very appreciable factor in the question of heating.

103. Witness thought that a hollow wall, with two thicknesses of $4\frac{1}{2}$ -inch brickwork, might be allowed, as it retained heat better than a thin wall. A wooden building could be made very warm, as it would heat quickly; he did not object to wood on the score of heating, but thought there would be no economy in its use, as the saving on first cost would be small and would soon be wiped out by the expense of painting and repairs.

104. Witness had had no experience of buildings constructed with curtain walls of concrete slabs or "Frazzi" material. He suggested that a building with a thin concrete wall, though not necessarily unhealthy, would be difficult to ventilate for the reason he had given. He did not think that it would prove economical to make walls thinner and increase the heating surface by way of compensation.

XVIII.

Dr. H. MEREDITH RICHARDS, Medical Officer of Health
for the Borough of Croydon.

Novel Materials and Methods.

105. Witness gave his views as to the hygienic properties of different types of walls proposed for use in school buildings which were not now accepted for permanent recognition: this was based on his experience in connection with hospitals and houses. Generally speaking, he considered that if walls were made thinner the heating power would require to be increased to an impracticable extent. If the area of glass was extended beyond a certain point, the loss of warmth would be so great that effective heating would become impossible: this difficulty had actually arisen at the Manchester Children's Hospital. In domestic buildings he had found that 9-inch brick walls without rough-cast were cold and produced rapid condensation, thus making the rooms damp; 9-inch walls with rough-cast

would be fairly comfortable, provided the rooms were heated with hot-water pipes and adequate heating surface were allowed. Additional heating power was also required in connection with the more thorough ventilation which was now desired.

106. Witness had had experience of a corrugated iron building lined with matchboarding, and found it easier to heat than a building lined with 14-inch brick walls. He could not think that a building with $3\frac{1}{2}$ -inch concrete walls could be satisfactorily heated. The condensation when the rooms were unoccupied would be very great, because of the rapid cooling of the walls; and condensation was increased by the non-absorbent character of the material.

XIX.

Mr. W. E. RILEY, F.R.I.B.A., M.Inst. C.E., Architect to the London County Council.

Novel Materials and Methods.

107. Witness stated that he had been authorised by the London County Council to give evidence on the building law in London in relation to steel skeleton and reinforced concrete construction, and he laid before the committee information as to changes in the building law to which the Council had deemed it necessary to seek Parliamentary sanction in the interests of economy of construction.

108. Under the London Building Act, 1894, the walls of buildings generally were required to be of the thicknesses prescribed in the First Schedule to that Act. In more recent years, however, instead of the pressure of the roofs, floors, floor loads, &c. of buildings being transmitted to the foundations by walls as contemplated by the 1894 Act, a different method of construction had been employed. An iron or steel framework was erected, in which the loads to be borne were concentrated at various points and transmitted to the foundations by pillars instead of being distributed over the whole of the walls. In such buildings the provision of thick walls in addition to the steel framework was not only superfluous as regards stability, but prevented economy, by reason of the unnecessary expense in the cost of brickwork and by taking up valuable floor space.

109. The Building Act did not empower the Council to consent to any reduction in the thickness of walls in such cases, and, as several applications were made for consent to such buildings which it was decided the Council were powerless to approve, they resolved to seek an amendment of the Building Act to legalise such buildings within the county. The Council considered the Building Codes of American and other cities in which this form of construction is employed, and put forward

definite rules which, after some amendment, had been embodied in Part IV. of the London County Council (General Powers) Act, 1909.

110. Witness considered that the adoption of steel frame construction would effect an important economy in floor space. He estimated the saving in area on certain specific plans at about 8 per cent. as compared with brick enclosing walls. Other advantages in this method would be a possible reduction of cost of foundations in consequence of the lessening of the weight of the building and also increased speed of erection. But it was very difficult to speak definitely at present as to the relative cheapness of steel frame and brick construction, since the former was new, and there had been as yet little experience to enable anyone to judge of the effect of this alteration in the law. The London bricklayer had acquired a facility in laying bricks from centuries of work, and it would probably take time to adapt the men to new methods of construction. He did not think that in any case there would be much saving in the use of steel-frame construction for a one-storey building; 14-inch brickwork would probably be as cheap for this purpose as anything else.

111. The Council also, in section 23 of their General Powers Act of 1909, already mentioned, obtained power to make regulations with regard to reinforced concrete construction, in which concrete is scientifically strengthened or reinforced by the addition of steel bars or rods. The Council were of opinion that investigation and experience of this form of construction were not yet sufficiently advanced to justify definite rules being put forward in a Bill as was done in the case of steel skeleton construction. The regulations as to reinforced concrete construction were now under consideration, but some little time must necessarily elapse before they were confirmed by the Local Government Board and became operative.

112. Witness would be more cautious in authorising construction in reinforced concrete than in steel frame, both on account of the lack of complete evidence as to the behaviour of reinforced concrete, and because any element of error in its use might be more disastrous.

113. Speaking generally on these new methods of construction, witness desired to refer to the interests of the public in regard to the appearance of buildings; not only colour but also shape might be lost, in his opinion, in the case of schools erected in these materials, and they would probably detract from the picturesqueness of the locality in which they were placed.

Building Laws.

114. The London County Council do not present their plans relating to the construction of schools to the district surveyors, as the Council contend that they are exempt under the Building Act in regard to the construction of a school building. Witness

was aware that non-provided schools in London have had to comply with the building laws, as interpreted by the district surveyors. He regarded the application of the requirements of the building laws as regards warehouses to schools as unreasonable in some respects; for instance, 112 lbs. per square foot was an ample allowance for floor-load for school purposes, but the General Powers Act of 1909 specified double this amount for warehouse buildings. He would not hesitate to support any suggestion that schools should be classed with exempted buildings as regards building laws.

XX.

Mr. H. D. SEARLES-WOOD, F.R.I.B.A., F.R.San.I.,
Past President of the Architectural Association, Chairman
of Council of the Royal Sanitary Institute; of
157, Wool Exchange, E.C.

Possible Means of Economy under present Regulations.

115. Witness considered that for the finish of internal walls a dado of hard plaster painted might be used instead of glazed brick; the latter was unpleasant to the eye, and caused a great deal of condensation. Dadoes required to be disinfected from time to time. The painted plaster would be more economical, and could be used for free-arm drawing.

An economical and efficient method of constructing urinals was to build a plain wall, cemented and coated with a mixture of pitch and tar.

Novel Materials and Methods.

116. Witness did not consider that reinforced concrete would prove economical for ordinary school buildings, if employed in the form of solid walls. The expense of shuttering and centring for a small building would swallow up any saving in material as compared with 14-inch brickwork.

117. He thought concrete would be cheaper if used in connection with steel stanchions for thin curtain walls of 3 to 5 inches in thickness. There were, however, considerable difficulties in this form of construction. If the curtain walls were on ordinary expanded metal the concrete was liable to crack, especially at the joints in the metal, allowing damp to penetrate; then the metal rusted. The reason of the cracking was that the wall was not sufficiently rigid, and twisted under the pressure of the wind at the points where the sheets of metal overlapped. Steel-frame construction could only be handled properly by specialists; a slight defect in workmanship might affect the stability of a steel-frame building very seriously. Expanded metal should only be used with Portland cement, as any plaster containing sulphates quickly destroyed the metal by rust.

118. A new form of expanded metal, called Hy-rib, had recently been introduced, which got over some of the difficulties. It was strengthened by ribs, which gave sufficient rigidity to prevent twisting. It could be erected by ordinary workmen, and was very light, so that there was a saving in the cost of carriage. At most places the aggregate required for the concrete could be obtained locally, and the only materials that would have to be brought from a distance would be the light metal sheets and the cement. There would be the same risk of rusting with this form of construction as with ordinary expanded metal if damp got through the concrete. Witness had no experience as to the comparative freedom from cracking of cement on Hy-rib and on expanded metal, as Hy-rib had only just been invented.

119. Witness pointed out that in any form of concrete construction it must be remembered that the material was non-absorbent, and so there was a great deal of condensation on the interior of the walls as the dew-point varied; this could be avoided by making the walls hollow, or giving them an internal facing of a softer plaster.

120. He did not consider that curtain walls built up of cast blocks were satisfactory; they were too porous, and required a finish of waterproof cement outside. He had no experience of "Frazzi" for external walls, but saw no objection to it if properly rendered with cement.

121. He thought a solid 3-inch concrete wall would prove unsuitable for a school building on account of the difficulties of temperature: it might be possible to increase the heating sufficiently to make the rooms comfortable in winter, but there would be excessive condensation on the walls, and in summer it would be nearly as hot as an iron building.

122. Witness considered that for temporary buildings wood was preferable to iron. In country districts timber schools erected on the Swedish system would be quite satisfactory and would last for 30 years. He submitted the following description of this method of construction.

"The foundations should be of cement concrete, and on the damp course a sole-piece or plate is laid, shaped with a slope to throw off the water from the weather-boarding, and with a deep groove to receive the vertical plank, 11 inches by 3 inches, double-tenoned, of which the walls are made. The external and internal walls are all alike in this, that they are of 3-inch solid deal. These planks are capped with a pole plate, which is also grooved to receive the planks. The external walls are then covered with tarred felt, and on the tarred felt 1-inch by 2-inch fir battens are fixed, and on the battens 1½-inch weather-board, which is ploughed and tongued, and has a deep splay to throw off the water. The angles and the windows are covered with 6-inch by 1-inch boards to protect the joints where the weather-boards meet. The roof is made with 6-inch

by 2-inch rafters, 3 feet apart, with 6-inch by 2-inch ties, and the roof is covered with double-tenoned planks and covered with tiles or slates, &c.

The upkeep of wooden houses, owing to the amount of external painting, was a heavy item, and as an alternative, in lieu of the weather-boarding, the battens could be covered with laths and the external face rough-cast."

123. Another satisfactory form of wooden building was the "Doecker" pavilion, which was constructed of weather-boarding on battens, with layers of insulating material at the back of the weather boarding, and again at the back of the battens; on these were placed styles and rails with grooved panels, which were covered with a patent non-inflammable material about $\frac{1}{4}$ inch thick. The floors were made double. The whole building was thus insulated with plenty of air spaces, which acted as non-conductors.

124. Witness was not favourably impressed with "uralite" as a covering for walls. Slabs of this material had been used at Osborne for outside walls, on ordinary timber, fixed with galvanised nails, and the cost of upkeep had been excessive; the "uralite" decayed round the nails. The same objection did not appear to apply to "uralite" slates as roofing, where the slabs were smaller and less exposed. It would not be possible to protect it with a rough-cast facing as the slabs are made at present, since the face is too smooth to hold the rough-cast.

125. Witness regarded a 9-inch brick wall covered with rough-cast as quite satisfactory for a school; it would be quite dry, and with sufficient heating power quite healthy. He preferred it to an 11-inch hollow brick wall, which had no advantages in point of strength, and was very resonant; also he thought the cavity of a hollow wall was always more or less damp.

Byelaws.

126. Witness thought that the building byelaws might be relaxed to permit of the erection of timber schools. The general objection to timber for building was for the protection of the public from fire, and this did not apply in the case of schools, which were usually detached and had ample space round them. It would be much more satisfactory if school buildings were exempted from the operation of structural byelaws, and the best way of effecting this exemption would be by legislation.

XXI.

Mr. CECIL A. SHARP, A.R.I.B.A., of the Firm of
Cecil Sharp and Lee Clarke, Architects.

Novel Materials and Methods.

127. Witness submitted a description of a school designed by him for the Managers of the North Surrey District Schools at Anerley.

"The entire area of the site (which was composed of stiff clay) was dug over and a spit removed and brought up to a level with hard core, upon which was placed a platform of ballast and cement-concrete 6 inches thick, with 2 feet thick under the stanchions carrying the roof trusses, and 9 to 12 inches thick under the position of the external walling. Pipe-trenches were formed in the concrete for all hot water warming and gas-pipes, the former converging to the boiler in the heater-room in a basement, this latter being built as hollow walls formed of 9-inch and 4½-inch thicknesses, with a 2-inch space, and having a vertical damp sheeting of thick slates bedded in cement upon the outside of the walls.

"The building was first commenced and completed in a steel frame construction of very slight scantlings, and the roof-trusses likewise in steel, fixed. This framing consisted of channel sole-pieces laid upon the concrete platform previously mentioned. Upon these were erected the angle frames, having intermediate framing where required for all trimmings for the openings forming doors and windows, all being bolted, angle-cleated, and plated at the junctions as necessity required. To carry the main-roof trusses over the hall, stanchions were erected with angle-plate seatings embedded in concrete blocks, and from these stanchions were spanned across the hall trussed steel curved-ribbed girders to carry the roofing, having angle-cleats to take purlins and plates and ceiling-joists, the latter to form a curved ceiling.

"To form the walls of the building externally and internally a special concrete slab was formed of a dovetailed character, each slab fitting one into the other, and being about 1 foot 9 inches by 1 foot 5 inches by 2 inches thick, and not too heavy for a man to handle comfortably. They have a V grooved all round on the edges, into which is run and grouted liquid cement as the blocks or slabs are built into position. Upon the inside and outside of the walls so constructed, to cover all steel framing, expanded metal is fixed, the entire surface of the walls and ceilings internally being finished with marble plaster, and the external walls finished with cement rendering ¾-inch thick. The work as finished has the appearance and rigidity of a brick-built structure rough-cast upon the outside, and becomes, one might say, a monolith. It is absolutely rigid and of a most substantial character and perfectly weather-proof.

"The entire building was erected in a remarkably short space of time, only taking from commencement to finish of all walls, steelwork, plastering, joinery, roofs, covered drains and erection of the brick-built latrines, 15 weeks. The steelwork was completed in six weeks, the walls in three weeks, and the plastering and cement rendering completed in four weeks. The finished thickness of the walls is only $3\frac{1}{2}$ inches, including the plaster and external cement rendering. The walls are as sound proof as ordinary 9-inch brick walls, and as rigid. The roofs were boarded and slated with green slates.

"Efficient natural ventilation is provided, there being properly disposed inlet and outlet ventilators in walls and ceilings, and the radiators for artificial heating are of the ventilating, fresh warm-air, type."

128. The cost of the building was $51\frac{5}{8}d.$ per foot cube, and worked out at $8l. 4s. 6\frac{1}{2}d.$ per scholar. The central hall was larger than would be required under ordinary circumstances, as it was to be used as a gymnasium; it might have been reduced from 64 feet 9 inches in length to 45 feet, if only to be used as a central hall, in which case the total cost would have been $7l. 8s. 1d.$ per scholar. as against $8l. 4s. 6\frac{1}{2}d.$ The expense was increased in comparison with a brick building by the greater heating necessary on account of the thin walls, amounting to about 20 per cent. extra heating surface, or about 150*l.* additional cost.

129. The building was of the nature of an experiment, and witness was of opinion that he could now improve on it. The only serious difficulty that had arisen was in respect of cracks in the concrete blocks going through the wall; but this did not occur in many places; these were due to expansion and contraction of the steelwork, and occurred where there were stanchions of 5-inch by 3-inch section or more; they might be obviated by using built-up sections instead, as the smaller sections had not sufficient expansion to affect the concrete. He thought that the steelwork could have been reduced to the extent of 15 per cent. with safety, involving a corresponding diminution of cost. When the cracks occurred, they were remedied by cutting them out in a V-shape, about 5 to 6 inches wide, and making good with expanded metal and cement, finishing with rough-cast.

130. Witness thought it would be an improvement to substitute hollow walls in concrete slabs for the solid wall. He had designed a special block of a dovetail character, which would go over the steelwork without any expanded metal; thus, by practically isolating the steelwork from the concrete, in a manner which he described, he would overcome difficulties of expansion and contraction. This would not add to the expense, as it would save considerable cost by avoiding expanded metal covering to the steelwork.

Witness also drew attention to the necessity of having thoroughly seasoned concrete blocks; if just cast, the blocks first expanded and then contracted again. Blocks six months old had reached their final state and would not develop flaws or show movement.

131. Witness had also erected a building of iron and wood for the purposes of an infirmary for the Wandsworth Guardians; it was constructed of wood framing, with expanded metal on the inside and plastered, with asphalted felt and corrugated iron of the Canadian pattern on the outside. In this case the extra cost of heating was considerable, as the roofs as well as the walls were covered with iron. He had tried the experiment of a wooden frame with expanded metal on both sides, but found that the wood, even if well seasoned, moved so much that it cracked the cement all over. The timbering was 4 inches by 4 inches with sheets of expanded metal, and $\frac{3}{4}$ -inch cement rendering on the top of the metal.

Byelaws.

132. Witness stated that both the buildings he had described were classed as temporary under the byelaws, and put up under a renewable licence. No byelaws would allow the erection of a building with walls less than 9 inches thick, and so the use of his system for schools would be prevented. He thought there should be a byelaw covering schools alone, and giving facilities for their erection in lighter constructions than at present allowed, *e.g.*, in steel and concrete; the relaxations might be somewhat on the lines of the revised regulations of the London County Council in relation to ferro-concrete buildings.

XXII.

Mr. THOMAS SHELMEKDINE, Surveyor to the Corporation of Liverpool since 1871.

Actual Cost of Buildings as erected at present.

133. Witness stated that he found the cost of schools which he had designed varied considerably, according to materials and finish. The most recent of his Authority's schools (Loraine Street), for 940 children, worked out at 11*l.* 1*s.* per head, including the cost of playgrounds and boundary walls. The playground at this school was quite up to the average requirements, giving about 29 square feet per head. With present materials and methods of construction he did not think they could build cheaper than about 10*l.* to 11*l.* per head, excluding land and furniture. The cost per cube foot would be about 5*d.* for a central hall or 6*d.* for a corridor school.

Possible Means of Economy under present Regulations.

134. Witness thought that economies might be effected in several directions. In poor districts, where the children were not clean, glazed brick dadoes and other expensive details were to a great extent necessary, but they might be dispensed with in schools attended by children whose parents might be of a better class. Similarly a saving might be secured in latrines and closets in neighbourhoods where the habits of the children did not necessitate as strict supervision as in the case of the poorer classes, where they would be subjected to rougher usage.

135. In the playgrounds, asphalte, costing about 2s. per square yard in Liverpool, could be used instead of granolithic, costing about 4s. He had already adopted granolithic instead of stone for staircases, and found there was a considerable saving.

Novel Materials and Methods.

136. The witness explained the plans of a new school for 700 children in one of the suburbs of Liverpool; the accommodation in this school provides for 14 classrooms on the 10-foot standard on one floor, with a central hall and playground on 30-foot standard.

The form of construction is as follows:—

The site being fairly level it is proposed to build from a brick base.

The school walls will be of concrete slabs, covered on the outside with rough-cast, and plastered inside, the lower portion of the walls being finished with a highly-glazed cement dado, the structure being strengthened at all angles with steelwork, making the whole a steel-framed construction, erected on concrete foundations, the lower parts being faced with red brick. The walls would be about $4\frac{1}{4}$ inches thick finished.

The roof will be covered with Welsh slates, with ordinary brick chimneys, open fireplaces being provided in teachers' rooms only, the remainder of the school being heated by means of a heating system of the low-pressure type. The thin walls might necessitate additional heating power.

Economies are proposed to be exercised in the flooring of the classrooms and the central hall, it being proposed to introduce one of the best examples of patent jointless flooring, which has been used with satisfactory results in various schools throughout the country. These economies in flooring might of course be effected in any school.

From this design tenders have been obtained, and the lowest, amounting to 5,700*l.* (including all fees), works out at equivalent to 8*l.* 2*s.* 10*d.* per head. This sum included 1,050*l.* for the playground and offices.

137. There would be a considerable saving as against brick, which would have to be 14 inches thick to pass the byelaws. The quantity surveyor estimated the cost of this in brick at 5,800*l.* for the main buildings and 1,050*l.* for playground, &c., or a total of 6,850*l.*; thus brick construction showed a net increase of about 25 per cent. over concrete for the main building. The building as designed would be passed by the local building surveyor.

138. The witness considered that steel stanchions with a hollow curtain wall with double concrete slabs would be warmer but more expensive. It would be possible to place an upper storey in this kind of construction over a first floor of ordinary brick construction, the steel framework being carried from the ground through the brick.

139. The witness said that 25 years ago to cope with an epidemic he introduced a timber form of construction with plastered interior, erected on brick foundations and with slated roof. These buildings had lasted perfectly well. More recently this form of construction had been employed in making an annexe to an existing temporary school. The effect of the interior is precisely the same as an ordinary school with boarded flooring, plastered interior, windows glazed and finished as in a permanent building. The walls are covered on the outside with lapboarding, painted and sanded. Exception might be taken to this form of construction where large numbers of children are to be accommodated, but with periodical attention to the exterior, and repair, it is found to be quite suitable and will have a very long life.

140. He said that a 9-inch brick wall with rough-cast outside, or 11-inch hollow wall, would not pass the Liverpool byelaws.

XXIII.

MR. J. OSBORNE SMITH, F.R.I.B.A., Architect to the Girls' Public Day Schools Trust, Lecturer on School Hygiene for the Royal Sanitary Institute; of 7, Old Queen Street, Westminster.

Causes of Increase of Cost of School Buildings.

141. Witness submitted a table, showing the increase of cost of the buildings erected for the Girls' Public Day Schools Trust. The prices per foot cube were as follows:—1884, 5 $\frac{3}{4}$ *d.* and 6*d.*; 1885, 6*d.*; 1887, 5 $\frac{3}{4}$ *d.*; 1888, 6*d.*; 1892, 6 $\frac{3}{4}$ *d.*; 1895, 7 $\frac{3}{4}$ *d.*; 1896, 8 $\frac{1}{4}$ *d.*; 1902, 8 $\frac{1}{2}$ *d.*; 1905, 10*d.* and 10 $\frac{1}{2}$ *d.*; 1907, 10*d.* and 11 $\frac{1}{2}$ *d.*; 1909, 8*d.* All these schools, except the first, were in or near London; they were rather more costly than elementary schools; a comparison might be taken with an elementary school built in 1902, which cost 7 $\frac{1}{4}$ *d.* per foot cube, showing a

difference of about $1\frac{1}{4}d$. The most marked rises in cost were after the Building Act of 1894 and the Building Act Amendment Act of 1905. The last case cited showed a lower cost; this was due partly to extreme simplicity in all details, and partly to depression in the building trade; the Committee for whom the building was put up had not much to spend, and cut out everything that was at all superfluous, some items being reduced even to an extent which witness considered unwise.

142. The rise in cost per foot cube was due, in witness's opinion, to the following causes; (a) the increase in labour rates, which was a very important factor; (b) the greater stringency of the Building Acts and additional cost of sanitary requirements, though he did not take exception to these; (c) the precautions against fire, in London; (d) the higher standard of warming; (e) the increased space for teaching special subjects, and larger floor space per child, as affecting the total cost.

Possible Means of Economy under present Regulations.

143. Witness suggested that the cost of schools might be reduced if the plan was arranged in large areas, so that partitions could be easily erected or removed without affecting the structure, and without going to the expense of putting in girders when a change was made; this scheme would also be convenient for the purpose of varying the sizes of classrooms as required. The plan would provide for all smoke and ventilation flues being in the outside walls, in the piers between the windows, so that they would always be available however the partitions were arranged. The piers could be arranged in multiples of 10, 11, or 12 feet as found most suitable.

144. Other possible economies might be found in less costly ventilation; the "Plenum" system was only necessary in exceptional cases; witness suggested simple windows, easy to open, for summer, and ample warmed-air inlets for cold weather. He thought also that rooms were built of unnecessary height, —partly to meet difficulties of planning, such as staircases—and that 12 to 13 feet was ample, if the ventilation were properly managed. The aspect of sites was another factor in cost, though not a great one; it was really more important from a health point of view; but the more rooms that could be built with a south-east aspect, the less expenditure was necessary on warming.

Novel Materials and Methods.

145. Witness submitted a plan of a Sanatorium erected from his designs at Harrow School in 1906. The outer walls were of timber framing, 4 inches thick, cased on both sides with "Fram" slabs, 2 inches thick on the outside and 1 inch thick on the inside; the roof was covered with asbestos slates; the floor was a table of "Fram" material rendered with cement

and covered with linoleum, forming practically a jointless floor on a cement table, the legs of which were piers of steel and concrete in a hillside. The cost, on a very difficult site, had come out at 6*d.* per foot cube for the building alone, or 8½*d.* including the heating, sanitary arrangements, gas, &c., which were more expensive than they would be in a school; on a flat site the building could have been done for 5*d.* He thought this kind of construction could be made perfectly suitable for public elementary schools; it might be better to use a simple steel framework instead of wood, and brick flues would have to be added. From the point of view of durability, it would be necessary to strengthen the dados by fixing a 2-inch slab inside along the bottom of the wall instead of a 1-inch one; the former would stand any ordinary blow. The 2-inch slab outside, with ½-inch cement or rough-cast on it, would be safe from damage by the children. The "Fram" material was easily repaired, as it could be sawn like wood, and the upright studs were fixed to suit the width of the slabs. The Harrow building had stood remarkably well and had needed very little repair.

146. Witness did not think schools could be built cheaply in reinforced concrete; and he disapproved of a construction in simple concrete slabs on the ground that the thin walls would make the building cold. He would not object to a 9-inch brick wall covered with rough-cast for a single-storey school, assuming sufficient constructive strength; he would prefer this to an 11-inch hollow wall, which he did not consider strong, although it would be warmer than a 9-inch wall. Class rooms with 9-inch walls would require to be warmed by hot water; fireplaces would not be sufficient. He thought that a thin wall would be satisfactory, if made impervious to moisture, and strong enough to carry the strain on it; the additional warming needed was only a matter of increasing the heating surface. He suggested that, with the plan he had described, for providing large rooms capable of being partitioned in various ways, as the piers contained all flues, the spaces between them could be filled to the height of the classroom with movable material, such as wood and glass. The brick piers might be replaced with steel construction. He had built a gymnasium on this principle, with fixed uprights, and movable material between them above the dado to a height of 7 or 8 feet; above this was a series of hinged sashes, which could be opened so as to make the room practically an outdoor school.

Byelaws.

147. Witness stated that local byelaws tended to add to the cost of buildings, especially in small places, which based their byelaws on City byelaws; for instance, he had been required at Bromley to build an inside wall of a three storey-building 14 inches thick in order to conform with the byelaws, although

a 9-inch wall would have been amply strong enough. Every time he built a school he had to waste brickwork to satisfy the byelaws.

148. The byelaws also hampered experiments in new forms or materials; local authorities might not object to buildings of exceptional construction, but they were afraid to go outside their byelaws in order to pass these, especially as they felt that the first case they passed might lead to a series of others. If they had large discretionary powers to vary the application of their byelaws, they might be more ready to consider novel proposals. At present district surveyors exercised no discretion whatever, but simply stuck to the letter of the law.

149. Witness thought that something ought to be done to take schools outside the ordinary regulations of the byelaws. Since 1894 they had been treated as buildings of the warehouse class and overloaded with excessive strength. If full plans and specifications were passed by the Board of Education and all sanitary questions investigated by the Local Government Board, he thought there was no need for the building to be subjected to the operation of local byelaws; there was really no occasion for the local authority to intervene, except to exercise the usual supervision during building, so as to ensure that the plans were properly carried out and the proper materials used. It would be desirable that schools should be exempted from the byelaws in the same manner as buildings erected with the approval of the Board of Agriculture and Fisheries.

XXIV.

Sir ALEXANDER ROSE STENNING, F.R.I.B.A., President of the Surveyors' Institution; of 121, Cannon Street, E.C.

Possible Means of Economy under present Regulations.

150. Witness was of opinion that some saving might be effected if plaster-work were omitted on interior walls above dado height. The walls could be pointed and lime-whited or coloured, and he thought, from a sanitary point of view, it was better to have plain walls which could simply be whitewashed than plastered walls which required more elaborate cleaning. The use of glazed bricks or tiles for dadoes should be limited as much as possible; he admitted that there was no great saving in a cement dado, as compared with one of glazed brick, when the cost of maintenance was taken into consideration.

151. Witness also thought that there was much extravagance at present in regard to heating and ventilation. For heating, he preferred a good open stove; though low-pressure hot water was cheaper in maintenance, it was less healthy, and in country schools there was a difficulty in getting the stoking of a boiler

properly done. In regard to ventilation, a great deal of the expensive apparatus used for mechanical ventilation was unnecessary; an open window was quite the best means of ventilation.

Novel Materials and Methods.

152. Witness was not acquainted with any novel material which would be more economical for the purposes of school buildings in country districts than brick or stone. Concrete was the only material that could be substituted for those named, and the use of this would certainly effect no saving, unless possibly in a large school in London. Being an absorbent material, concrete would require to be rendered in cement to make it weather-proof. Even with a large school, he doubted whether there would be much advantage in reinforced concrete construction; the number of window openings and dividing walls in a school were hindrances to economy with this form of construction; also it would not be safe to allow a building to be erected without special supervision and skilled workmen, which added considerably to the expense; and the cost of carriage of materials and maintenance would be heavy. He had no experience of the use of concrete or other slabs on a steel framework, but did not think that these materials would prove cheaper than brick.

153. Witness did not recommend the approval of brick walls less than 14 inches in thickness. In exposed places they were not weather-proof, and any reduction in cost which might be effected by the use of thin walls was counterbalanced by the necessity of providing piers to carry the weights. Thus, a 9-inch wall rough-cast with piers would effect no substantial saving, especially as rough-cast was liable to continual damage, which increased the cost of maintenance.

154. For temporary or semi-permanent buildings, as for instance in a mining district, witness considered wood the most suitable material; and he preferred a wooden erection with weather-boarding outside to wood and iron, or wood with a rough-cast finish. His experience was that timber houses were very warm and durable, and, if properly constructed with concrete footings, should last for 50 or 100 years.

Byelaws.

155. Witness stated that the requirements of Local Authorities were generally not excessively stringent, but in building the cost of details was frequently raised by the requirements of individual surveyors. The London Building Acts placed schools on a level with warehouses, theatres, &c.; and, with regard to the strength of floors and walls, the stringency of the Acts, which was in itself excessive, was increased by administrative action on the part of the London County Council. Schools

ought to be exempted from the operation of structural byelaws, so that when the plans had been approved by the Board of Education no further approval by Local Authorities should be required. If necessary, legislation should be introduced to effect this end ; he did not think there would be any opposition. The supervision of the actual work of construction on the lines of the approved plans should still be left to the Local Authority and the district surveyor, as should the sanitary arrangements, which involved questions which could sometimes only be decided by local knowledge.

XXV.

Mr. W. NOBLE TWELVETREES, Past President of the Civil and Mechanical Engineers' Society, Member of Council and Fellow of the Society of Engineers, Member of the Institution of Mechanical Engineers, Member of the Société des Ingénieurs Civils de France, Member of the Royal Sanitary Institute, &c.; of 195, Bedford Hill, S.W.

Novel Materials and Methods.

156. Witness submitted a statement as to the suitability of reinforced concrete for school buildings. He pointed out that the material (a) lends itself to any style of architecture ; (b) can be employed for the construction of every detail from foundations to roofs, the building being monolithic throughout ; (c) can be used for the construction of a skeleton frame supporting and transmitting all loads to the ground ; the panels of the walls and roofs can be filled in with ordinary materials, which, having no load to carry in the walls, may be much thinner than the usual type ; (d) makes a building of exceptional strength and capable of acting as a single unit, and thus unaffected by any subsidence or local weakness under the foundations ; (e) is one of the best fire-resisting materials known ; (f) is suitable on hygienic grounds, being impenetrable by vermin, harbouring no germs, and checking exhalations and moisture ; being non-porous and non-conductive, it conduces to equable temperature ; (g) concrete increases in strength with age and is free from decay and corrosion, thus needing no maintenance or repairs beyond cleansing and painting for decorative purposes. On the last point, he drew attention to the fact that the durability of steel and concrete used separately had never been questioned by architects, and, therefore, their durability when used in combination ought to be accepted.

157. As regards the cost of a reinforced concrete building, witness did not think there would be any saving over brick in the case of small single-storey schools. He had obtained

estimates for a Sunday school at Mitcham, which showed a cost of 850*l.* for reinforced concrete as against 800*l.* for brick. The initial cost of moulds and plant would more than swallow up the saving in use of concrete on a small job. On buildings of two storeys there would be a saving of about 5 per cent. all round on first cost and on higher buildings an additional 5 per cent. per storey up to a maximum of 15 or 20 per cent. In any case there would be a saving in maintenance, as no repair would be required. Witness would prefer to make a reinforced concrete skeleton, like a steel skeleton, and fill in the walls with concrete hollow blocks, bricks, or hollow bricks. There would be a saving of 10 to 20 per cent. over a steel skeleton, and the same over ordinary brick construction.

158. Taking the items of construction separately, witness said that in foundations reinforced concrete offered great economies for unstable soil, while even in fairly solid soil reinforced concrete column bases required far less material than ordinary footings extending beneath the whole length of the walls, and thus effected a saving. He quoted a case of a building at Newcastle-on-Tyne where a reinforced concrete raft had been put under the building, and had resulted in a saving of 50 per cent. on the original design of a concrete foundation of piers going down to the solid. Similarly, at the General Post Office column foundations in reinforced concrete had been used and saved about 50 per cent. on ordinary concrete blocks. Work in this material for foundations would not require so much supervision as in the case of walls and roofs.

159. In regard to columns, he estimated that reinforced concrete would give a saving of about 25 per cent. over steel columns to carry the same loads and could be used to carry a strain where a brick column would be of prohibitive cost, as the safe compressive strength of concrete properly reinforced averages ten times that of brick masonry. The concrete column would also be better than protected steel for resisting fire. He agreed, however, that from the point of view of the Board of Education steel columns from a good maker would require less supervision during erection than reinforced concrete columns, unless the latter were executed by thoroughly reliable and experienced contractors.

160. Witness thought that the only economy in the construction of walls arising from the use of reinforced concrete would be due to the possibility of replacing thick masonry by thin curtain walls, as these would not have to carry any load. Interior walls could be put up very cheaply of special slabs or by plastering cement mortar on expanded metal or other types of lathing.

161. As regards floors, he admitted that reinforced concrete was dearer than timber, but considered it would usually come out cheaper than steel joists with plain concrete or tile panels; he had particulars of three cases where the saving was 11½, 12½,

and 15 per cent. respectively. The reinforced concrete was also less susceptible to heat, and so safer in case of fire, than steel joists. In this matter also he agreed that less supervision was required in the use of steel during the erection of a building.

162. For the purpose of staircases there was no saving in the use of reinforced concrete, but the material was better. When exposed to fire, it did not splinter and crack like stone, it did not burn like wood, and it did not buckle like steel.

163. He thought that for flat roofs there was an economy in the use of reinforced concrete; there would be no saving in a sloping roof, but the material might be employed with advantage, as it would make a roof impervious to moisture and immune from injury by fire.

Building Regulations.

164. Witness said it was necessary that proper regulations should be framed controlling the use of reinforced concrete. At present architects were only guided by the regulations drafted by the Institute of British Architects, which, having been issued some years back as a reasonable guide in the state of knowledge then prevailing, were not to-day entirely satisfactory and not sufficiently complete to be accepted as a standard code of regulations. Much more care was required in design and supervision when reinforced concrete was used than was the case with brick, and he would not advise the Board to accept any proposals for schools to be built in this material from small authorities or local builders without taking qualified technical advice, or having evidence that such advice had already been devoted to the preparation of the proposals. If this material were used to any large extent the Board would probably have to be much more critical of the plans and specifications than they were at present.

Byelaws.

165. Witness considered it essential, in order to facilitate the adoption of reinforced concrete on economical lines, that school buildings should be exempt from local byelaws and placed in the same position as Government buildings.

XXVI.

Mr. C. F. WARD, A.R.I.B.A., Borough Architect,
Newport, Mon.

Actual Cost of Buildings as erected at present.

166. Witness stated that there had been no elementary schools erected in Newport recently; the last one built was opened in 1904, and cost 15*l.* 18*s.* 7½*d.* per child; another school opened in

1903 cost 19*l.* 2*s.* 5½*d.* per child. Rooms for manual instruction are provided in both instances, and in the latter case rooms for cookery and a gymnasium.

Possible Means of Economy under present Regulations.

167. Witness drew attention to the waste which resulted from the failure to make provision for the future when schools were planned. Out of 36 departments in Newport, there were only three schools which had not had to be enlarged after their erection. He suggested that, in districts where the population was increasing or likely to increase, temporary schools should be erected in the first instance; then, when the district had grown to its fullest extent, a permanent building could be put up planned as a complete scheme and the temporary school moved elsewhere.

168. He also said that it was a mistake to attempt to economise by using cheap materials; cheap sanitary fittings in particular wore out very quickly. As an instance of the extra expense in maintenance arising from inferior work, he quoted one of the last schools built in Newport; the first cost was 29,447*l.*, and in the five years which had elapsed since it was opened, 1,044*l.* 15*s.* 6*d.* had been spent on repairs; it had practically needed to be replastered and reroofed.

Novel Materials and Methods.

169. Witness considered that the ferro-concrete system of construction was well adapted for use in towns, and if used in school buildings of three storeys would result in a saving of 5 per cent.; there would be no saving on a single-storey building. It would be necessary, in order to ensure safety, that the design should be based on the rules laid down by the Royal Institute of British Architects, and that full specifications as to materials should be submitted; also tests should be made from time to time by the local surveyor and a final certificate issued by him. A competent clerk of works would have to be employed to secure proper workmanship. The floors would have to be made sound-proof, as ferro-concrete carried sound readily; he suggested that they might be constructed of hollow blocks with reinforced beams and slabs. Internal divisions might be made of thin fireproof partitions. There was difficulty in securing dryness with thin solid concrete walls, and these also caused considerable condensation in damp weather; he thought it would be better for the walls to be constructed in two thicknesses, with a 2-inch space between. Extra heating would be required in such buildings. He agreed that ferro-concrete was a material which would have to be used with very great care, and it was doubtful whether a Government Department should experiment with it. In districts subject to mining operations, or where foundations were poor, ferro-concrete offered many advantages for obviating damage by settlements.

170. Witness approved of steel-frame construction, provided it was brought into line with the latest London Building Act. At present in the provinces the local byelaws require the walls with steel framework to be made as thick as in brickwork, so that no economy was possible; if thin hollow walls could be introduced there would be a great saving.

171. Witness did not think that any novel methods or materials would effect a saving in the construction of permanent schools in country districts, as compared with the materials obtainable locally. For temporary buildings he thought that hollow walls of terra-cotta or concrete blocks might be allowed; buildings erected on this principle were more healthy and durable than iron structures and cost little more in the first instance, while the expense of maintenance was far less.

Building Regulations.

172. Witness suggested that where efficient cross ventilation or mechanical ventilation was provided the height of rooms might be reduced; the ruling consideration would be the lighting. He thought the Plenum system of ventilation worked satisfactorily if there was an engineer to control it; but it was objectionable for elementary schools, as it taught the children to work with closed windows.

XXVII.

Mr. A. WILLIAM WEST, Architect; of 3A, Lyall Street,
Belgrave Square, S.W.

Novel Materials and Methods.

173. Witness stated that he had adopted a method of construction for two buildings, the National Sanatorium at Benenden and the King Edward VII. Hospital, Windsor, which offered several advantages over ordinary brickwork. The chief novelty in it consisted in the introduction of "Frazzi" material, which had been employed for the erection of churches and chapels and for interior walls, but had not previously been used on as large a scale as in these hospitals.

174. "Frazzi" material is similar to terra-cotta and is made in slabs about 2 feet by 1, with tubular perforations 3 inches thick. It requires rough-cast or some weather-resisting material on the outside. It has been used simply as a filling and not to carry weight. It is not easily broken by kicks or blows, but it can be pierced with a hammer or pickaxe. For that reason, though it does not split up in fire, even under very heavy tests, it is unsuitable for use as a party wall between adjacent buildings. It has only recently come into use in this country, but has been employed in Italy for centuries for outside work and particularly for floors.

175. The system adopted by witness was to erect a structure of steel joists and stanchions and to fill in the intervening spaces with "Frazzi." The exterior was covered with *lias* or Portland cement rough-cast, and the interior plastered. The main stanchions, of varying sizes according to the work to be done, were placed about 12 or 14 feet apart, and embedded in concrete footings; a cross joint carried the floor and walls above, thus saving the usual concrete and brick footings, and effecting a large reduction in the cost of this part of the work. The slabs were laid with the perforations horizontally; the joints were run in cement. For the floors small intermediate joists were used and filled in with "Frazzi"; on this coke breeze was laid, and then the finished floor. As regards the transmission of sound, "Frazzi" was much better than a $4\frac{1}{2}$ -inch brick wall, as there is a buffer of dead air between two blocks. The floors were equally sound-proof. If it were found that sound travelled through the perforations, it would be possible to lay the blocks vertically.

176. No difficulty has arisen in the surface of the buildings from the expansion or contraction of the steel joists, because very little steel was used and it was well protected. As regards the temperature it was not necessary to allow for extra heating power in consequence of the thinness of the walls as compared, for instance, with an ordinary 14-inch brick wall, as the buffer of air in the brick preserved an even temperature. No damp came through the joints.

177. Witness handed in a table showing the cost of the Benenden Sanatorium and the Windsor Hospital as furnished, with comparative figures of the estimated cost of similar buildings in brick.* The Benenden Sanatorium cost $8\frac{1}{2}d.$ per foot cube, exclusive of lighting, grates, sanitary and drainage work, and fencing; but inclusive of teak doors and floors throughout, and rounded angles at the ceilings and floors. The Windsor Hospital cost, as a whole, $8\frac{3}{4}d.$ per foot cube. Witness considered that an efficient and comfortable school building could be put up on this system for $6d.$ to $6\frac{1}{4}d.$ without fittings.

178. Witness had estimated the comparative cost of a panel 10 feet long and 10 feet high in brick and in "Frazzi." Taking brickwork at 13*l.* the rod, such a panel would cost, in 9-inch brickwork, 6*l.* 1*s.* 11*d.*; in "Frazzi" 4*l.* 1*s.* 9*d.*; in 14-inch brickwork 8*l.* 16*s.* 1*d.*; in "Frazzi," with 3 by 3 stanchions, 5*l.* 13*s.* 1*d.*; in 18-inch brickwork, with a second panel of the same size in 14-inch brickwork above it, 17*l.* 7*s.* 5*d.*; in "Frazzi," for the same 200 feet super, with stanchions, 11*l.* 19*s.* 6*d.*

179. He quoted a case of an isolation hospital near Derby, where alternative estimates for stone and "Frazzi" were obtained. These estimates were, for the administration block, stone, 980*l.*, and "Frazzi," 713*l.* 15*s.*; for block No. 1, 500*l.* and 428*l.* 15*s.*; for the laundry block, 400*l.* and 288*l.* 15*s.*

* See Appendix H.

180. Witness gave the following additional reasons which reduced the cost of construction in "Frazzi":—

- (1) The material being light, cartage was a comparatively small item; thus at Benenden, which is 7 miles from a railway station, the actual cost of the raw material on the ground was not 10 per cent. higher than the cost at Windsor, though the railway journey to Kent is actually longer.
- (2) The rapidity with which the work proceeded increased its cheapness as a building material.
- (3) The thin walls made it unnecessary to have window linings: he estimated the saving in a window 4 feet 6 inches wide and 9 feet high, with a "Frazzi" wall instead of a 14-inch brick wall, at 2*l.* 17*s.* 3*d.*, or, if the brick wall were an 18-inch one, at 3*l.* 7*s.* 7*d.*; that was assuming plain wood linings.

Byelaws.

181. Witness said that the chief obstacle in the adoption of "Frazzi" construction on a large scale had been the requirement of a certain thickness of wall by local byelaws and Building Acts. At Windsor the byelaws were altered, with the consent of the Local Government Board, so as to allow its use. At Benenden there were no byelaws. He thought that if byelaws could be relaxed a great impetus would be given to experiments in this kind of construction.

XXVIII.

Mr. G. H. WINDOWS, A.R.I.B.A., Architect to the Derby Corporation from 1898 to 1904, and since then Architect to the Derbyshire Education Committee.

Actual Cost of Buildings as erected at present.

182. Witness handed in a statement of the cost of 20 schools erected in the last three years by his Committee, showing that the average price per head, exclusive of land and furniture, was 11*l.* 7*s.*; the price per foot cube was from 6½*d.* to 8*d.** He said that, in his opinion, the economy to be expected from the adoption of novel methods of construction was insignificant, but that the cost of schools could be kept down by controlling the use of ornament. The Derbyshire schools are now built with a few courses of brindled bricks at the bottom and common red bricks above. He did not like central halls; various types of buildings, including some with four wings, had been introduced to secure cross ventilation for every room. He did not

* See Appendix I. for details of the cost of some of these schools.

consider this added greatly to the expense, as the external walls were only 11 feet high. In such buildings lead gutters were avoided.

Possible Means of Economy under present Regulations.

183. Witness said that stone buildings, even in a neighbourhood where stone was easily available, were more costly than brick because of the additional labour involved, the price per cubic foot being about 8*d.* He considered that the cost of play-sheds might be saved if open corridors or verandahs were provided running along the sides of classrooms. The cost might further be reduced if the external walls of schools were built 9 feet high to the plate, and such arrangement might well be allowed, provided that at least half the area of the room was 14 feet high to the collar. Vendors of sites usually insist on boundary walls being 5 feet 6 inches or 6 feet high. If the Board specified 4 feet as a sufficient height for such walls, except, perhaps, adjoining main roads, local education authorities would be helped in negotiations and expenses saved. Instead of glazed brick dadoes, witness used a hard plaster coated with dark green composition suitable for free-arm drawing, with three courses of glazed brick at the bottom. The comparative price was as follows: glazed brick, 9*s.* per yard; plaster, 10*d.* per yard; painting, first cost, 10*d.* per yard. The paint would need to be renewed every three or four years at about 5*d.* per yard.

Novel Materials and Methods.

184. With regard to materials other than bricks, witness had found that reinforced concrete did not effect a saving. Three tenders were invited for a school at Palterton, and the lowest amounted to 1,878*l.* 12*s.* 3*d.*; the school was to be erected in the ordinary system of reinforced concrete construction, *i.e.*, concrete throughout with a rough-cast finishing. This was a single-storey building for 150 children, and the position was a favourable one for the manufacture of concrete. The concrete walls were to be, in accordance with the requirements of the Local Government Board, two-thirds the thickness of what they would have been in brickwork, *i.e.*, 9-inch external and 6-inch internal walls. The contractors proposed 4½-inch walls, which witness would not have approved. Tenders were invited for the same building in brickwork, with the result that a tender for 1,750*l.* was accepted, and thus a saving of 7 per cent. over reinforced concrete was effected. Witness said he had seen particulars of a seven-storey building of reinforced concrete, with 4-inch walls, but the danger involved in this method of construction was that the curtain wall would be liable to crack, and the steel in consequence be affected by damp. He had seen an open-air school at Bradford constructed in "Frazzi" material, and had observed no faults in construction; but it did not appear to him strong enough for a permanent school.

185. Witness said that he was averse to cavity walls, whether in brick or in slab material, where they could be avoided, partly because birds and vermin might find their way into the cavity and partly because the iron ties were liable to corrode. Glazed stoneware or gunmetal ties would alone be suitable. If the material were porous, the cavity in exposed situations would need to be 3 inches wide, with a consequent increase in the cost of the ties.

186. Witness did not fully approve of 9-inch solid brick walls; they would require to be strengthened by means of piers to receive roof trusses and the like, and, unless coated with rough-cast, the walls were not, as a rule, sufficiently impervious. But he saw no reason why liberty should not be given to build schools with such walls, provided a proper covering of the best cement rough-cast were added. In installing the heating apparatus, some increase in the heating surface would be necessary to make up for the thinness of the walls.

187. In the matter of corrugated iron buildings, witness was of opinion that these were undesirable for school use. They were hot in summer and cold in winter, and the sheets corroded away at the bolt holes. The result was that after a time wind caused a continuous rattle. A new iron building at Shuttlewood cost 3*l.* per head, exclusive of site and furniture. A second-hand building at Codnor had cost 2*l.* 10*s.* per head.

188. Witness considered that there was nothing so suitable for a temporary school as wood; and that in districts where coal was being worked, with consequent settlement of the surface, where the future of schools was uncertain, or where the population was fluctuating, wooden buildings should be erected. The joints would take up any settlement of foundation. Wooden buildings were not subject to such great variations of temperature as iron buildings. They might rest on sleepers, which could easily be arranged so that they could be taken out and replaced if they perished. Open corridors with a door from each classroom into the same should be insisted upon, so that in the case of fire the children could get into the open air at once. If raised from the ground and properly painted, there was no reason why a wooden building should not be good for 50 years at least, and he thought the period of loan might be increased in the case of such buildings from 15 years, the maximum now allowed by the Local Government Board, to 25 or 30 years.

189. At Long Eaton a Doecker Building had been erected for 220 children with double walls and a layer of felt, and was one of the most satisfactory schools they had. The total cost of the building, including plumbing, electric lighting, &c., was 1,028*l.* 15*s.* 1*d.*, the foundations 80*l.* 8*s.* 3*d.* The boundary walls and out-offices, which would be used for the permanent building when erected, cost about 650*l.* The actual cost of the building, apart from plumbing, electric light, &c., was 954*l.*

A British firm were prepared to put up a building identical in all respects for the sum of 748*l.*, or a saving of 206*l.* on the German price. The report of the medical officer of health for Long Eaton as to the hygienic conditions of school buildings was better for the temporary school than for the older permanent schools which exist there.

XXIX.

Mr. W. GILMOUR WILSON, F.R.I.B.A.; of 5, Bloomsbury Mansions, Hart Street, W.C.

Causes of Increase of Cost of School Buildings.

190. Witness was of opinion that the practice followed in some districts of having school buildings designed by an official architect in the Local Authority's office tended to increase the cost. When there was competition among architects, there was an inducement to effect economies both in planning and in methods of construction; even if an architect was invited to build a school, he would still be in competition with others, and it would not do for him to plan an extravagant school when he knew that economical ones were being erected elsewhere, and that his future employment would depend upon his production of a good school at a minimum cost.

Actual Cost of Buildings as erected at present.

191. Witness gave particulars of three schools built from his designs: Squires Lane Council School, Finchley; Hyde Council School, Hendon; and an enlargement of Bell Lane Council School, Hendon. The first of these was expensive, being on a sloping site which involved much underbuilding; it also had an unusually large playground; the senior school cost about 20*l.* per head, the infants' about 12*l.* 10*s.* The Hyde School came out at 13*l.* 16*s.* 9*d.*, including a caretaker's house (which cost about 7*s.* per head), although this also was on a sloping site which entailed boundary walls which were more or less retaining walls and a great deal of filling in and underbuilding; on a level site this school could have been built for 13*l.* 5*s.* The cost per foot cube was about 6¼*d.* or 6½*d.* There were two large central halls, so large that the Board of Education suggested reduction, glazed brick dadoes in the corridors, halls, and classrooms, and terrazzo floors; the two latter items represented about 15*s.* per head; the schools altogether were finished in rather a superior way. The contracts were not taken at an exceptionally low price, although 10 to 15 per cent. lower than they would probably have been three years ago. The labour prices at Hendon were the same as in London, and in addition there was considerable expense for carriage.

Possible Means of Economy under present Regulations.

192. Witness did not think there was much room for reduction in cost in the case of schools designed in open competition. Glazed brick dadoes and special floors such as terrazzo might be omitted, but he did not recommend this from an educational or sanitary point of view, as regards the effect on the children. A small economy might also be secured by the use of floor boards laid on concrete instead of wooden blocks. It was quite possible under the building regulations for a Local Authority to cut down the finish of a school to a considerable extent. Cement might be used instead of glazed brick for dadoes, but Authorities generally preferred brick.

Novel Materials and Methods.

193. Witness had not tried novel materials in school building. For the Hyde School he had obtained tenders for reinforced concrete floors from specialists, and found that they came out about 20 per cent. dearer than floors of ordinary steel joists and concrete. These tenders were from the patentees, so that no cost for royalties was included. His experience in the use of concrete instead of bricks for ordinary houses suggested that the difference in cost as against ordinary materials was slight. He was not in favour of building with steel framework and concrete piers and thin curtain walls; there was not enough brickwork in schools, where large window spaces were necessary and the piers consequently occupied a very small area, to make this system very advantageous from the point of view of cost; a school was quite unlike a factory, which might have a long continuous wall with small openings, or a lofty building, which would require thick walls. He had tried whether it was more economical to build a thin wall with piers or to thicken it throughout, and thought the latter method slightly cheaper in an ordinary school; it also had the advantage of avoiding projecting corners. He would have no objection to a 9-inch brick wall with rough-cast facing in a sheltered position, if a hard facing brick and Portland cement mortar were used, though he was not fond of rough-cast, which required a good deal of upkeep. He preferred this to an 11-inch hollow wall; this would require the walls to be thoroughly tied, and the rooms disconnected to prevent transmission of sound.

Building Regulations.

194. Witness thought the Board of Education might give more guidance to local authorities. In particular he suggested that they should specify the safe load which floors should carry. The Board might also, on grounds of cost, veto glazed brick dadoes or ornamental floors, but he would be sorry to see this done.

XXX.

Mr. C. H. WYATT, Director of Elementary Education,
Manchester, formerly Clerk of the Manchester School Board.

Increase in Cost.

195. Witness stated that there had been a rise in the cost of school buildings in Manchester of late years, owing to the provision of classrooms and central halls; also larger sites were now bought, usually of about 2 acres for 1,000 children. The addition of centres for woodwork and domestic subjects, which had been built in connection with most of their new schools, increased the apparent cost. All these items were necessary. The central halls were in constant use for religious instruction, singing, and drill in wet weather. Playground space was of the highest importance in Manchester, where, as a rule, children had no place for recreation except the streets, even in the suburbs. A good many centres for special instruction had been built lately, and they had almost caught up with the demand for these. The standard of requirement in heating had also risen, and involved some extra expense. The cost of building materials in Manchester had declined somewhat recently owing to depression in the building trade.

Actual Cost.

196. Witness said that the average cost of elementary schools erected in Manchester between 1870 and 1910 was 13*l.* per place. At the present time the cost of the schools per foot cube was about 5*d.*, including everything except land. He had built a school for a voluntary committee at Mobberley, in Cheshire, for 5*l.* per place; this was for a holiday school only, and everything was of the simplest character; but it could be converted into a satisfactory school for constant use at the cost of an additional 1*l.* The present cost of heating, by low-pressure hot-water pipes and radiators, was about 1*s.* 3*d.* per cube yard.

Possible Means of Economy.

197. Witness thought that his committee were now effecting a saving by building schools of one storey instead of two; they had not yet got their single-storey buildings as cheap as he hoped they would, but he was satisfied that they were more economical, as well as better for educational purposes, than two-storey ones; there was a saving on staircases and scaffolding, and some also on roofs and walls.

198. He did not consider there was much room for economy in materials. Sound brick construction was as cheap as anything; for facing they largely used terra cotta, having given up stone owing to difficulties with masons. For interior finish, glazed

brick, costing about 10s. 6d. per square yard, was cheaper than tiling, which cost about 13s. 6d.; they had tried cement, but abandoned it, as it did not prove satisfactory, and they had quite given up wainscoting.

199. He found that economy had resulted from the placing of all work with their own Architect's Department. They had lately appointed a quantity surveyor, paid at a fixed salary, and anticipated further economy from this. Formerly the cost of a school was never kept within the estimate; on their last nine schools there had been a saving on the estimates.

Novel Materials and Methods.

200. Witness had no experience in the use of novel materials. Their Architect's Department had considered the question of such use and reported on it.

Building Regulations.

201. Witness thought the Building Regulations of the Board of Education on the whole good, but submitted criticisms on points of detail. In particular he suggested relaxation in regard to the following:—

- (a) Damp-proof courses in boundary walls are unnecessary if hydraulic lime is used in the mortar.
- (b) A thickness of 4 inches of concrete over the whole area of the building would be sufficient, instead of 6 inches as required in the regulations.

Byelaws.

202. The local byelaws in Manchester were much more drastic than the model byelaws, and caused unnecessary expense in the erection of schools; for instance, they required 23-inch walls for a three-storey building, and subjected schools to the same requirements as warehouses and mills.

APPENDICES.

APPENDIX A.

PARTICULARS AS TO COST OF YIEWSLEY COUNCIL SCHOOL,
SUPPLIED BY MR. H. G. CROTHALL.
(See Abstract of Evidence, p. 41.)

The following are the comparative details of cost of the school as built (first column) and if erected in ferro-concrete and slab (second column). The accommodation is for 320 children, with a separate block containing Cookery and Manual Training centres; the area of the site is $1\frac{1}{2}$ acres. There are covered playgrounds and sanitary conveniences for both sexes:—

	£	s.	d.	£	s.	d.
Preliminary - - - -	280	0	0	250	0	0
Excavator and Concretor - -	184	12	4	540	7	6
Slab concrete - - - -				91	4	0
Bricklayer and Asphalter - -	993	13	4	153	4	0
Mason and Granolithic paving	93	12	8	14	8	0
Tiler - - - -	130	3	11			
Carpenter, Joiner, and Iron- monger - - - -	776	0	0	238	4	9
Founder, Smith, Heating, and Gas - - - -	167	15	0	275	0	0
Plasterer - - - -	98	5	4	122	11	6
Plumber, Glazier, and Painter	288	7	9	218	7	9
Cookery and Manual Training block - - - -	925	0	0	632	0	0
Latrines, playgrounds, drainage, and paving - - - -	797	0	0	665	0	0
Total - - - -	4,734	10	4	3,200	7	6

The school as built contains 125,682 cubic feet at $5\frac{3}{4}d.$ per foot cube; in ferro-concrete and slab it would contain 89,080 cubic feet at $5\frac{1}{4}d.$ Thus the difference of cost per foot cube is $\frac{1}{2}d.$ in favour of ferro-concrete, and there is a large saving in the number of feet cube, due to the different method of construction.

Both sets of figures are based on the same schedule of prices, and relate to the complete school and centres. The school proper (of 320 places), exclusive of centres, latrines, playgrounds, &c., cost 3,012*l.* as compared with a school of similar capacity in ferro-concrete, which would have cost 1,903*l.*

The description of materials is as follows:—

(a) As built—

Concrete foundations, brick footings and asphalte damp course to all walls.
All walls built of local stocks with red dressings, pointed outside, dinged and distempered inside.
Glazed brick dadoes to all walls.
Roof, trusses and rafters wood, covered with feather-edge boarding and Broseley tiles.
Flats over cloakrooms, &c., concrete and asphalte.
Flooring to hall:—Pitch pine wood block.
Flooring to classrooms:—Batten flooring nailed to dovetailed fillets bedded in concrete.
Corridors and cloakroom floors:—granolithic paving.
Heated by open fires.
Lighted by gas.

(b) As proposed, if erected in ferro-concrete—

Ferro-concrete piers and roof.
 Walls between piers, and division walls:—Concrete slabs.
 External red brick facing to cill height.
 Roof covered with asphalt.
 Walls and ceilings plastered inside.
 Dadoes:—Coloured cement polished.
 Exterior above cill height rendered in cement.
 Floors:—Pitch pine wood block to hall; batten flooring on dovetailed fillets to classrooms.
 Corridors and cloakroom floors:—Granolithic paving.
 Heated by low pressure hot water
 Lighted by gas.

APPENDIX B.

NOTE BY MR. FISHER ON COST OF BUILDINGS MENTIONED IN HIS EVIDENCE.

(See Abstract of Evidence, p. 47.)

With regard to the manual and Cookery rooms built by me in 14"-brickwork and those about to be built in reinforced brickwork, I have had some difficulty in arriving at any detailed comparison of cost between the two systems.

As before mentioned, the former cost 1,100*l.*, and the latter will probably cost 700*l.*, including fittings. The fittings amount to 200*l.* in both cases.

I found it cheaper to construct the 14"- brick building in two floors, and thus save in roof and foundations at the cost of a floor and staircase. The reinforced building I have designed in one floor, taking advantage of the cheapness of the foundations and wall area.

It is therefore clear that any comparison of the cost of a given part in both buildings is likely to be misleading.

In the following list I have selected those items in the total cost which seem to bear upon the question.

Such trades as Glazier, Painter, &c., apply equally to both and need not be included.

I have included "Joiner," as there would be some difference in the depth of window and door linings, though I think that the saving effected in this case might prove unusually large. Generally, the cost of raw materials have risen since the 14"- brick building was built.

E. FISHER.

Reinforced brickwork in one story.

	£	s.	d.
Foundation work—Floor area about 216 yards	-	-	22 0 0
Brickwork—wall area about 472 yards	-	-	137 10 0
Tiling and leadwork—area covered 216 yards	-	-	74 10 0
Carpenter and Joiner	-	-	172 0 0
Total	-	-	<u>£406 0 0</u>

14"- brickwork in two stories.

	£	s.	d.
Foundations, first floor, and staircase—floor area about 234 yards	144	16	6
Brickwork—wall area about 445 yards	178	11	6
Tiling and lead work—area covered 117 yards	36	0	0
Carpenter and Joiner	201	0	0
Total	£560	8	0

APPENDIX C.

i. PARTICULARS AS TO COST OF ELEMENTARY SCHOOLS RECENTLY ERECTED FOR THE STAFFORDSHIRE EDUCATION COMMITTEE, SUPPLIED BY MR. J. HUTCHINGS.

(See Abstract of Evidence, p. 51.)

(a) Accommodation. (b) Cost per head for buildings, including heating, lighting, boundary walls, offices, and outbuildings. (c) Total cost per head, including site and all incidental charges and furniture. (d) Cubical contents of main building in feet. (e) Cost of main building per foot cube in pence.

Name of School.	(a)	(b)	(c)	(d)	(e)	Remarks.
		£ s. d.	£ s. d.	Feet.	d.	
Audley, Wood Lane - -	280	11 13 11½	13 18 2½	114,254	4½	
" Butt Lane - -	400	10 13 9	12 12 9	196,434	3¾	
" Talke - -	318	12 11 10½	15 6 5	144,109	4½	Cookery room.
Hamstall, Ridware - -	82	11 1 6	12 18 7½	29,533	4½	
Kingswinford, Pensnett Bird's Meadow - -	268	12 10 0	16 17 10	109,690	4½	Cookery room.
" Wordsley Lawns-wood Road - -	418	10 0 2	13 18 1½	179,924	3½	
Penkridge - -	168	12 5 3	14 5 2	74,572	4½	Cookery room.
Rolleston - -	138	13 11 0	16 8 4½	55,384	4½	
Tutbury - -	324	11 14 5	13 18 1	130,001	4½	Cookery room.
Willenhall, Albion Road - -	1,090	8 19 10½	10 9 9½	480,332	3½	Drill hall.
Stafford, Tenter Banks - -	520	9 11 9	12 9 8	248,889	4	

All the schools in this list were completed in 1909, except the fourth, fifth, sixth, and last, which were in course of erection in May 1910.

ii.—STAFFORDSHIRE BUILDING PRICES.

April, 1910.

Nature of Material.	Unit.	North Staffs Potteries District.	Stafford.	South Staffs.
		s. d.	s. d.	s. d.
Common brickwork 9" reduced, pointed one side as the work proceeds.	per yd. super	4 0	4 9	4 4
Best red pressed brick facing.	per yd. super	3 0	3 0	3 0
Extra only to salt glazed brickwork.	per yd. super	9 0	9 0	9 0
Concrete foundations 5 to 1 -	per yd. cube	12s. to 14s.	14 0	12s. to 14s.

Nature of Material.	Unit.	North Staffs Potteries District.	Stafford.	South Staffs.
		<i>s. d.</i>	<i>s. d.</i>	<i>s. d.</i>
Concrete 6" thick under floors	per yd. super	2 0	2 6	2 0
Best 6" quarries in cement -	per yd. super	3 0	3 6	3 0
Best 1½" blue dust bricks in cement.	per yd. super	2 4	2 6	2 4
13" by 7" blue coping double throated.	per foot run	0 10	1 0	0 10
Roof tiling to 4" gauge including laths and torching.	per square	33 0	35 0	35 0
Fir in plates, purlins, rafters, joists, &c.	per foot cube	2 <i>s.</i> to 2 <i>s.</i> 3 <i>d.</i>	2 <i>s.</i> to 2 <i>s.</i> 3 <i>d.</i>	2 <i>s.</i> to 2 <i>s.</i> 3 <i>d.</i>
Fir in roof trusses - - -	per foot cube	2 <i>s.</i> 9 <i>d.</i> to 3 <i>s.</i>	2 <i>s.</i> 9 <i>d.</i> to 3 <i>s.</i>	2 <i>s.</i> 9 <i>d.</i> to 3 <i>s.</i>
14" red flooring in 3" widths nailed to breeze.	per square	25 0	27 0	25 0
2" sashes and frames including weights, cords and pulleys.	per ft. super	1 3	1 3	1 3
Steel joists - - - - -	per cwt.	9 0	9 0	9 0
Lead in flashings and gutters	per cwt.	24 0	24 0	24 0

APPENDIX D.

PARTICULARS AS TO THE COST OF ELEMENTARY SCHOOLS RECENTLY
ERECTED FOR THE LANCASHIRE EDUCATION COMMITTEE, SUPPLIED
BY MR. H. LITTLER.

(See Abstract of Evidence, p. 57.)

(a) Accommodation, (b) Contract Price, (c) Cost per head, (d) Cost per foot cube.

Name of School and Date of Completion.	(a)	(b)	(c)	(d)	Remarks.
		£.	£ s. d.	d.	
Levenshulme (1907) -	1,040	10,750	10 6 9	5·46	Two blocks.
Droylsden, Man- chester road (1907).	822	8,240	10 0 6	5·87	Two blocks.
Droylsden, Market street (1907).	822	9,790	11 18 2	6·08	Two blocks and handicraft centre (cost 1,088 <i>l.</i>).
Ansdell (1907) -	210	2,150	10 4 9	6·83	Part of scheme.
Litherland (1908) -	1,200	11,966	9 17 11	5·95	Two blocks, one of two stories.
Feniscowles (1907) -	250	3,018	12 1 5	7·03	Heavy cartage.
Royston (1907) -	788	9,130	11 11 9	4·56	Very heavy foundation work.
Edgworth (1907) -	190	2,210	11 12 7	7·79	Heavy cartage.
Bryn Gates (1909) -	400	3,900	9 18 5	5·77	Reinforced foundation.
Fleetwood (1907) -	600	6,729	11 14 3	6·77	Two stories.
Lostock Hall (1908)	500	6,729	10 7 9	5·49	
Andenshaw (1909) -	300	5,698	17 18 0	6·15	Combined cookery and laundry centre, handicraft and lecture rooms.
Cleveleys (1907) -	300	3,200	10 13 4	6·71	Heavy cartage.
Fulwood (1908) -	162	2,039	13 11 10	6·14	Part of scheme.
Huncoat (1908) -	300	3,940	13 2 8	5·57	
Penketh (1908) -	350	4,175	11 18 8	6·13	
A 8250.					

Name of School and Date of Completion.	(a)	(b)	(c)			(d)	Remarks.
		£.	£	s.	d.	d.	
Brierfield (1909) -	800	11,000	13	15	0	6.08	Cookery and handicraft rooms in basement.
Cadishhead (1909) -	450	4,747	10	11	0	5.46	
Lamberhead Green (1909).	500	4,739	9	9	7	5.02	Heavy foundations; approach road to form.
Great Harwood (1909)	900	14,270	15	17	1	6.85	Three blocks, one of two stories; separate two story block for cookery, laundry, handicraft, physics, and lecture-room.
Great Crosby (1910) -	500	8,181	16	7	3	5.37	Cookery, handicraft, laboratory and lecture-rooms on first floor.
Failsworth (1909) -	700	7,833	11	3	9	5.69	
Trawden (1910) -	770	8,237	10	14	0	6.06	Heavy cartage.
Padiham (1910) -	620	7,616	12	5	8	6.29	
Aspull (1910) -	300	3,340	11	2	8	6.36	
Adlington (1908) -	352	4,221	11	19	10	5.67	Separate cookery and handicraft block (cost 679 <i>l.</i>).
Ditton (1910) -	120	1,543	12	17	2	7.60	
Kirkham (1910) -	200	3,718	18	11	9	6.86	Separate cookery and handicraft block (cost 778 <i>l.</i>); street forming.
St. Anne's (1910) -	310	3,508	11	6	4	6.36	
Wrightington (1910)	120	1,490	12	8	4	6.81	
Flixton (1907) -	370	4,430	11	19	5	6.62	
Prestwich (not yet open).	548	7,524	13	14	7	5.96	Cookery, laundry, and handicraft rooms.
Hurst (not yet open)	150	1,812	12	1	7	6.78	

APPENDIX E.

PARTICULARS AS TO THE COST OF SCHOOLS RECENTLY ERECTED FOR THE CROYDON EDUCATION COMMITTEE, SUPPLIED BY MR. H. CARTER PEGG.

(See Abstract of Evidence, p. 58.)

(a) Accommodation. (b) Total cost. (c) Cost per place. (d) Cost of buildings only, exclusive of offices, playsheds, boundary walls and works to site. (e) Measurement in cubic feet of school buildings only. (f) Number of cubic feet per school place. (g) Cost per cube foot.

Name of School and Date of Erection.	(a)	(b)	(c)			(d)	(e)	(f)	(g)
		£	£	s.	d.	£			d.
(i) Ecclesbourne Road (1901)	1,210	15,465	12	15	7				
(ii) Portland Road (1902)	1,310	17,712	13	10	5				
(iii) Ingram Road (1905) -	1,166	16,469	14	2	6	13,611	527,975	453	6.19
(iv) Winterbourne Road (1907)	1,256	16,641	13	5	0	14,097	598,823	477	5.65
(v) Davidson Road (1908) -	1,200	15,639	13	0	7				
(vi) Tavistock Grove (1910) -	868	11,868	13	13	2	10,538	398,660	459	6.34
(vii) Crescent (Secondary) (1907).	403	13,000	32	5	0	12,287	520,000	1,290	5.67

(i), (ii), (iii), (iv) and (v) comprise a two-storey block for boys and girls, and a separate one-storey block for infants: each has a school-keeper's house.

(vi) consists of a two-storey block only.

(iv), (v) and (vi) have additional rooms for drawing, science and handicraft.

(v) is very similar to (iv), and the cube figures would not differ materially.

The separate cubes for Winterbourne Road are:—

386,502 for the boys' and girls' two-storey building.

212,321 for the infants' one-storey building.

At the rate of 5·65*d.* the cost of each is:—

For the two-storey building of 816 places, 9,098*l.*, or 11*l.* 3*s.* 0*d.* per place.

For the one-storey building of 396 places, 4,998*l.*, or 12*l.* 12*s.* 5*d.* per place.

(The accommodation of the infants' block is reduced to make it fairly comparable, as 396 places at 10 feet per place is the equivalent of 440 infants' places at 9 feet.)

The higher cube rate of Tavistock Grove is accounted for by the bad site, the foundations being carried down on concrete piers and arches 12 feet below the ground floor.

APPENDIX F.

PARTICULARS AS TO COST OF SCHOOL BUILDINGS, SUPPLIED BY MR. J. J. REDHOUSE.

(See Abstract of Evidence, p. 60.)

(i) *Hatfield Boys' School.*

Built 1905. Accommodation, 380. Walls hollow, of stock bricks, faced externally with local red bricks; two 4½-inch walls with 2½-inch cavity, tied with galvanised ties; piers 18 inches wide and 9 inches thick at intervals.

Floors of classrooms, pitch pine blocks; of passages and cloakrooms, tiles, both laid on cement concrete.

Heating by hot water from chamber in basement.

Roofs covered with tiles.

Walls finished in cement.

Cost of buildings and offices, 3,077*l.* 5*s.* 10*d.*, or 8*l.* 2*s.* 0*d.* per head.

Cost of playgrounds and fences, 292*l.* 14*s.* 2*d.*, or 15*s.* 5*d.* per head.

Total cost, 3,370*l.* 0*s.* 0*d.*, or 8*l.* 17*s.* 5*d.* per head.

(ii) *Arlesey Infants' School.*

Built 1895. Accommodation, 233. Walls of local brick 14 inches thick, with 16-inch plinth, faced with picked bricks; offices and boundary walls of 9-inch brickwork.

Floors of classrooms, deal wood blocks; of cloakrooms, tiles.

Heating by stoves.

Roofs covered with slates.

Varnished wood dado in classrooms, walls lime-whited above dado.

Cost of buildings, inclusive of fees, 1,696*l.* 6*s.* 4*d.*, or 7*l.* 5*s.* 7*d.* per head.

Cost of caretaker's house, 250*l.* 0*s.* 0*d.*, or 1*l.* 1*s.* 5*d.* per head.

Total cost, 1,946*l.* 6*s.* 4*d.*, or 8*l.* 7*s.* 0*d.* per head.

(iii) *Biggleswade Girls' and Infants' School.*

Built 1910. Accommodation, 300. Walls of local brick 14 inches thick, on reinforced concrete foundations; office walls 9 inches.

Floors of classrooms and cloakrooms, pitch pine blocks; of lavatories tiles, both laid on cement concrete.

Heating by stoves.

Roofs covered with slates.

Walls inside pointed and distempered.

Cost of buildings and offices, 2,090*l.* 0*s.* 0*d.*, or 6*l.* 19*s.* 4*d.* per head.

Cost of playgrounds and fences, 329*l.* 0*s.* 0*d.*, or 1*l.* 1*s.* 11*d.* per head.

Total cost, 2,419*l.* 0*s.* 0*d.*, or 8*l.* 1*s.* 3*d.* per head.

APPENDIX G.

PARTICULARS AS TO COST OF ELEMENTARY SCHOOLS RECENTLY ERECTED FOR THE BIRKENHEAD EDUCATION COMMITTEE, SUPPLIED BY MR. T. T. REES.

(See Abstract of Evidence, p. 61.)

Woodchurch Road Council School (opened 1905).

Accommodation for 1,020 children in 18 classrooms, 3 central halls, cookery, laundry, and manual instruction centres, teachers' rooms, &c.

Cost—School buildings, boundary walls, latrines, playsheds, and playgrounds, 15,000*l.*

Price per ft. cube for school buildings, including heating, lighting, ventilating, playgrounds, boundary walls, latrines, and sheds, 6*·*1*d.*

Price per child for school buildings, including heating, lighting, ventilating, playgrounds, boundary walls, latrines, and sheds, 14*·*7*l.*

Price per ft. cube, exclusive of playgrounds, boundary walls, latrines, drains, and playsheds, 5*d.*

Price per child, exclusive of playgrounds, boundary walls, latrines, drains, and playsheds, 12*·*09*l.*

Area of playgrounds—4,844 square yards (boundary walls on four sides).

Hemingford Street Council School (opened 1909).

Accommodation for 1,160 children in 21 classrooms, 3 central halls, 1 examination hall 80' by 33', cookery, laundry, and manual instruction centres, dining room 59' 6" by 24', teachers' rooms, &c.

Cost—School buildings (including electric lighting, ventilating, heating, boundary walls, latrines, playsheds, and playgrounds) 16,300*l.*

Price per foot cube, 6*·*01*d.*

Price per child, 14*·*5*l.*

Price per foot cube, exclusive of playgrounds, boundary walls, latrines, drains, and playsheds, 5*·*33*d.*

Price per child exclusive of playgrounds, boundary walls, latrines, drains, and playsheds, 12*·*47*l.*

Area of playgrounds 2,952 square yards (boundary walls on four sides).

Brassey Street Council School (in course of erection).

Accommodation for 1,200 children in 23 classrooms, 3 central halls, cookery and manual instruction centres, dining room and medical inspection room, teachers' rooms, separate building for infants.

Cost—School buildings (including electric lighting, heating and ventilating, boundary walls, latrines, playsheds, and playgrounds) 16,839*l.*

Price per foot cube (exclusive of house) 5*·*92*d.*

Price per child, 14.03*l*.
 Price per foot cube, exclusive of playgrounds, boundary walls, latrines,
 drains and playsheds, 4.97*d*.
 Price per child exclusive of playgrounds, boundary walls, latrines, drains,
 and playsheds, 11.79*l*.
 Area of playgrounds, 4,577 square yards (boundary walls on four sides).

APPENDIX H.

DETAILS OF COST OF BUILDINGS MENTIONED IN MR. WEST'S EVIDENCE.

(See Abstract of Evidence, p. 83.)

National Sanatorium, Benenden.

Cost of building per foot cube exclusive of terraces, fences, lighting, grates, sanitary and drainage work, &c., 8½*d*.
 The cost of the actual structure has been 10,970*l*. 4*s*. 4*d*.
 For a building constructed in brick on the same basis, the cost at 1*s*. 6*d*. per foot cube would have been 23,200*l*.
 Thus saving 12,229*l*. 15*s*. 8*d*.

King Edward VII.'s Hospital, Windsor.

Cost per foot cube of building:—

Administration building, complete (three stories high), 8*d*.

Exclusive of grates, lifts, electric lighting, heating, sanitary fittings, 6½*d*.

Out patient block and ward pavilion (three stories high), 9½*d*.

Exclusive of grates, &c., as above, 7½*d*.

Isolation block, teak floors as above, 5½*d*.

Taking the building as a whole, 8¾*d*.

The net cost of structure, apart from forming terraces, fences, gates, electric lighting, lifts, grates, drainage and sanitary work, fittings, gas, &c., was 13,915*l*. 7*s*.

If built in the ordinary way in brick-work this would have cost about 1*s*. 6*d*. per foot cube, or a total of 28,625*l*. 7*s*.

Thus saving 14,710*l*.

APPENDIX J.

PARTICULARS AS TO COST OF ELEMENTARY SCHOOLS RECENTLY ERECTED FOR THE DERBYSHIRE EDUCATION COMMITTEE, SUPPLIED BY MR. G. WIDDOWS.

(See Abstract of Evidence, p. 85.)

(a) Accommodation. (b) Total cost, exclusive of furniture and site.
 (c) Cost of boundary walls, latrines, drainage, and asphaltting. (d) Cubic

contents of main building in feet. (e) Cost of main building per cube foot.
(f) Number of cube feet per scholar. (g) Inclusive cost per head.

Name of School and Date of Completion.	(a)	(b)	(c)	(d)	(e)	(f)	(g)
		£	£		d.		£ s. d.
Shirebrook (1907) -	640	6,968	1,090	292,555	4 $\frac{3}{4}$	454	10 17 9
Sandiacre (1907) -	320	3,300	573	145,097	4 $\frac{1}{2}$	453	10 6 3
Marlpool (1907) -	216	1,996	525	84,552	4 $\frac{1}{2}$	391	9 4 9 $\frac{1}{2}$
Old Bolsover (1907) -	640	7,021	1,075	292,555	4 $\frac{7}{8}$	454	10 19 5
New Sawley (1907) -	156	1,459	365	51,867	5	332	9 8 4 $\frac{1}{2}$
Ludworth (1908) -	279	3,705	906	115,750	5 $\frac{3}{4}$	414	13 5 7
Hasland (1908) -	320	3,687	679	147,458	4 $\frac{7}{8}$	454	11 10 5 $\frac{3}{4}$
Tibshelf (1909) -	320	3,640	642	145,097	5	453	11 7 6 $\frac{1}{2}$
Newton (1909) -	156	2,148	787	53,151	6 $\frac{1}{8}$	341	13 15 5 $\frac{1}{2}$
Langley Mill (1909) -	316	3,285	644	133,570	4 $\frac{3}{4}$	422	10 7 11
Palterton (1910) -	150	1,750	467	49,870	6 $\frac{1}{8}$	332	11 13 4
Whittington Moor (1910) -	432	4,874	916	175,939	5 $\frac{1}{2}$	407	11 5 7
Whaley Bridge (1910) -	336	5,050	1,302	157,524	5 $\frac{3}{4}$	468	15 0 7
Long Eaton (1910) -	960	10,770	1,256	442,374	5 $\frac{1}{4}$	454	12 5 2
Codnor (1910) -	150	2,279	921	49,870	6 $\frac{1}{2}$	332	15 3 11

APPENDIX K.

TYPICAL EXAMPLES OF SCHOOLS ERECTED OR APPROVED FOR
ERECTION IN THE LAST THREE YEARS IN DIFFERENT
PARTS OF THE COUNTRY.

District.	Accommodation.		Cost per Head, inclusive of Playgrounds, Outbuildings, Boundary Walls, &c.*			Remarks.
	O.C.	Infants.	£	s.	d.	
Anglesey - -	380	100	10	18	0	Hall and 10 classrooms.
" - -	50	50	8	8	0	One room divided by partition.
Bedfordshire - -	336	—	10	14	3	Central hall and seven classrooms.
" - -	90	50	8	17	3	Marching corridor, school-room, and classroom.
Berkshire - -	446	148	11	17	4	Two separate blocks, hall, 12 classrooms, and corridor.
" - -	—	120	12	6	0	Corridor and three classrooms.
Brecknockshire - -	—	350	14	17	2	Hall and seven classrooms.
Bucks - -	370	230	13	0	0	Central hall.
" - -	32	26	12	10	0	Two classrooms.
Carmarthenshire - -	220	80	13	6	8	Hall and seven classrooms.
" - -	60	—	8	6	8	One room.
Carnarvonshire - -	140	60	16	0	0	Corridor, dining room, and four classrooms.
" - -	80	—	14	3	4	Corridor, dining room, and three classrooms.
Cambridgeshire - -	60	40	11	4	6	Two classrooms.
Cheshire - -	250	100	15	8	6	Two halls, eight classrooms, cookery, laundry, handicraft, and dinner rooms.

* These figures are taken from the estimates furnished by Local Authorities when the plans were submitted to the Board of Education for approval.

District.	Accommodation.		Cost per Head, inclusive of Playgrounds, Outbuildings, Boundary Walls, &c.			Remarks.
			£	s.	d.	
Cheshire (two de- partments).	O.C. 600	Infants. 300	11	4	5	One storey, three separate blocks joining, hall and six classrooms in each, Science room, laundry, cookery, and housewifery in separate block.
Birkenhead (two departments).	780	420	14	0	8	Hall and seven classrooms on each floor, cookery, and handicraft rooms, hall, and nine classrooms for infants.
Wallasey - -	300	120	9	9	0	(R.C.) School hall and six classrooms, schoolroom and classroom for infants.
Cornwall - -	104	48	11	10	0	Corridor and Verandah. Cookery centre.
" - -	42	20	8	4	6	One room divided.
Cumberland - -	104	32	13	8	5	Corridor and four classrooms.
Denbighshire -	200	100	17	0	0	Hall and five classrooms.
" - -	50	32	13	11	4	Schoolroom and classroom.
Derbyshire - -	—	320	10	6	3	New Pavilion type of school.
" (two de- partments).	664	332	10	10	0	New type, three separate blocks, each hall and six classrooms.
" - -	—	320	11	7	6	New type, hall and six classrooms.
Devonshire - -	260	—	14	16	0	Hall and six classrooms.
" - -	40	24	12	0	0	
Dorsetshire - -	120	68	11	9	4	Corridor and four classrooms.
Durham (two de- partments).	540	270	9	10	0	Corridor and six classrooms for each department.
" - -	68	40	11	2	2	Corridor and three classrooms.
" - -	393	398 (Junn. Dept.)	11	11	0	Hall and eight classrooms for each department.
Essex - - -	420	—	11	6	2	Hall and nine classrooms.
East Ham - -	516	516	12	16	4	Hall and nine classrooms for each department.
Walthamstow (three departments).	1,260	420	15	10	0	Two blocks and two storeys, hall and eight classrooms for each department. Cookery, laundry, and Handicraft Centre.
Chelmsford (two departments).	712	100	13	0	0	Two halls, marching corridor for infants, 18 classrooms.
Essex - - -	96	60	8	10	0	(C. of E.) 9" concrete walls, tile roof. Corridor and four classrooms.
Flintshire - -	110	50	13	0	0	Corridor and three classrooms.
Glamorganshire -	308	—	14	9	7	Hall and six classrooms.
" - -	—	156	17	9	8	Hall and four classrooms.
" - -	248	64	16	0	6	Hall and eight classrooms. Handicraft room and dinner room.
Gloucestershire -	130	80	14	10	5	Open verandah, five classrooms, cookery, handicraft.
" - -	—	180	11	19	5	Schoolroom with marching space and two classrooms.

District.	Accommodation.		Cost per Head, inclusive of Playgrounds, Outbuildings, Boundary Walls, &c.			Remarks.
	O.C.	Infants.	£	s.	d.	
Hampshire - -	—	380	14	13	8	Hall and seven classrooms.
" - -	22	18	14	7	6	Schoolroom divided.
Hertfordshire -	328	100	12	0	0	Hall and seven classrooms, cooking, handicraft.
Huntingdonshire -	81	32	10	0	0	Schoolroom and classroom.
Kent - -	160	90	12	0	0	Corridor and six classrooms.
" - -	140	60	13	0	0	
Lancashire - -	160	80	8	1	3	Corridor and "five" class- rooms.
" - -	250	120	12	0	4	Two halls, eight classrooms.
Liverpool (two de- partments).	600	340	13	16	4	Corridor and 19 classrooms, M.T. and cooking in separate block.
Blackpool - -	—	480	12	15	0	Hall and eight classrooms.
Manchester - -	260	128	14	13	9	Two separate blocks, hall and six, and hall and three classrooms (Pavilion type).
" - -	—	398	11	11	2	Hall and eight classrooms.
Leicestershire -	—	200	12	4	9	Hall and four classrooms.
Lincolnshire -	70	32	10	12	0	Schoolroom and classroom.
" - -	32	16	14	10	0	Schoolroom.
Middlesex - -	220	110	14	0	0	Hall and six classrooms.
" (three departments).	480	160	12	0	0	Two halls and 12 classrooms.
Tottenham (two departments).	920	500	14	15	9	Two storey and infants in separate block. Halls for each department. Handicraft centre, cook- ery and meals room.
Monmouthshire -	250	150	13	0	0	Hall and nine classrooms.
Norfolk - -	60	30	12	13	4	Schoolroom and infants room.
Northamptonshire	128	93	10	13	4	Pavilion type of school.
Northumberland -	500	250	11	11	4	Verandah, five classrooms.
" - -	—	150	9	0	0	Two separate blocks, hall, and 10 classrooms.
" (two departments).	520	—	13	0	0	Corridor and three class- rooms.
Nottinghamshire -	120	60	12	4	5	Hall and 10 classrooms.
Nottingham (two departments).	1,080	540	14	6	6	Corridor and three class- rooms.
Oxfordshire - -	400	200	10	0	0	Three blocks, each with hall and nine classrooms.
Oxford (two de- partments).	500	—	16	0	0	Two halls, 12 classrooms.
Somersetshire -	80	40	9	3	4	Two blocks, hall and six, hall and four classrooms.
Staffordshire -	324	—	10	7	11	Corridor and three rooms.
" - -	—	250	12	10	0	Pavilion type of school.
" (two departments).	624	396	9	0	8	" and cooking room.
Suffolk - -	340	143	11	3	7	" and detached hall.
" - -	48	24	9	8	10	Hall, corridor and 10 class- rooms.
Reigate - -	300	200	13	6	0	Schoolroom and classroom.
Croydon (two de- partments).	642	226	13	13	0	Two halls, 10 classrooms (two-storied).
Sussex - -	110	50	13	10	0	Two blocks, two storeys, each hall and seven classrooms. One storey, hall and eight classrooms.
						Corridor and four class- rooms.

District.	Accommodation.		Cost per Head, inclusive of Playgrounds, Outbuildings, Boundary Walls, &c.			Remarks.
			£	s.	d.	
Warwickshire	—	Infants. 200	13	2	7	Corridor and four class-rooms.
Birmingham	650	350	16	0	0	Two one-storied blocks. Two halls and 20 class-rooms.
Worcestershire	304	—	10	10	0	Hall and seven classrooms.
Yorkshire, E.R.	40	25	10	15	4	Classroom and infants' room.
" N.R.	210	90	10	9	4	Hall, one storey.
" W.R.	480	—	12	0	0	Hall and eight classrooms.
Bradford	—	250	18	18	9	Hall and five classrooms, cooking and handicraft room.
Huddersfield	400	200	13	6	3	One storey. Two halls and 12 classrooms, handicraft, laundry and cooking.
Douglas, I. of M.	400	—	9	15	0	Central hall, one storey.
London	320	175	21	12	8	Two storey, roof playground, two halls, 12 classrooms.
"	500	500	23	6	3	Two blocks, one storey, hall and seven classrooms in each, science and art rooms.
"	320	180	19	15	0	Two-storied building, two halls and 12 classrooms.

APPENDIX L.

DESCRIPTION OF THE THACKLEY OPEN AIR SCHOOL.

The Thackley Open Air School illustrates a type of construction which might be used with great advantage in School work. The building had to be erected at very short notice and completed as soon as possible. This meant either the adoption of wood framing with a covering of weather boarding or sheet iron, or some other type of construction which could be speedily erected.

I particularly wished to avoid the former method, for various reasons, and so a form of block construction was used.

The outer walls of the building above the foundations are 3" thick and are formed of blocks of specially prepared and burnt clay, laid in courses 10" high.

The blocks are keyed into one another horizontally and bedded in mortar which when set forms a solid wall. The saving in floor space in having the walls only 3" thick is considerable. The outer walls are self-supporting, and also support the lower portion of a tiled roof. The cross walls to the classrooms have two steel stanchions in each wall to support the weight of the centre portion of the roof.

The blocks with which the walls are built have vertical hollow grooves at intervals, to assist in maintaining an even temperature in the rooms, and to prevent the transmission of sound from one room to another.

The building was erected twelve months ago and was kept open during the whole of the year. It is situated in a somewhat exposed position, and has satisfactorily withstood the gales of last winter.

The inside of the walls to the classrooms are unplastered and undistempred, the blocks on the classroom side being left their natural colour, and are finished with a smooth surface, the joints being neatly pointed, giving the same result which would be obtained by lining the walls with glazed bricks, and so saving the enormous cost of this material.

The saving in the cost of walling and by the omission of glazed bricks, and plaster for the walls of this building, would amount to at least 60 per cent. for this portion of the work.

The whole of the woodwork in the building is stained with one of the many excellent preservative stains now on the market, thereby reducing the painter's bill, and also making a saving in the upkeep of this building.

REGINALD G. KIRKBY.

APPENDIX M.

PARTICULARS OF COST OF BUILDINGS DESIGNED ON FRAZZI SYSTEM OF CONSTRUCTION.

1. Estimate made for a schoolroom 35' 0" by 21' 0", with entrance lobby and additional room lengthening the building 6 feet more. Height to plate 11 feet. Cubic contents, if measured on our system, 55*l.* at 1*d.*; if measured with 14" walls in brick, 64*l.* at 1*d.* Our estimate for the work complete, including ventilators, and plastered ceiling throughout to the rafters and collar, 225*l.* This price works out at 4*d.* per foot cube on our own dimensions, but only 3½*d.* per foot cube on the dimensions if the building were built in brick.

2. Estimate for Combined Cookery and Laundry Centre. A 2-storey building 45' by 25', the lower storey forming a covered playground, with steel stanchions supporting the upper building, all cased, and cement rendered, &c. Price, including drainage, flues for stoves, special ironmongery to specification, complete steel frame, fire-proof floor, cooking ranges, portable copper, heating stove, three sinks, two lavatory basins, one watercloset, all water supply and plumbing, tiling with Broseley tiles, 664*l.* This building cubed in Frazzi comes out at 115*l.* at 1*d.*, or if built in brick work, 133*l.* at 1*d.*

3. Cookery and Manual Instruction Rooms. This building, consisting of two rooms, with accessories, one 40' by 22' and the other 45' by 22', cubed up in Frazzi at 120*l.* at 1*d.*, or in brick work 146*l.* at 1*d.* Our estimate amounted to 506*l.*, or 4½*d.* in Frazzi and 3½*d.* in brick. The estimate included the complete building, with the necessary steel reinforcements, double Roman tiles to roof, eight special ventilators in roof in 12" tubes and connections, ceilings plastered, walls rendered, set and distempred internally, but no drainage and fittings.

4. Estimate for proposed school, consisting of central hall, 60' by 23', cloak rooms, one each end of central hall, eight class rooms 24' 8" by 24' 4", four each side of central hall, the central hall being 16 feet high to plate with large turret ventilator, 26' high to ridge, and class-rooms 14' high to plate and 22' high to ridge, a heating chamber being provided, and the whole cubing out, in Frazzi to 520*l.* at 1*d.*, or in brick work to 625*l.* at 1*d.*

Our estimate, exclusive of drainage and fittings, amounts to the sum of 1,685*l.*, or 2½*d.* for brickwork, or 3½*d.* in Frazzi.

5. I am giving you the cubing in brickwork in each case, because it does not establish proper comparison to give you the cost per foot cube in our material.

The reason for the economy of the system in building is not, as seems very commonly to be supposed, only because the walls are built of our

material. The system is specialised in many other particulars besides that of the walls, and no comparison between the cost of building in brick and our material can be arrived at by simply taking the cost per yard super of walls finished in the particular manner required by the different materials.

6. As a matter of fact, I have on one occasion figured out the exact differences on the different bills of the builders' estimate. This was done at the request of the architects, who were designing a new kitchen for a hospital. This is a building very much of the school type, and the quantities for building in brick were taken off by their own surveyor, and handed to us so that we might price out the estimate in brick, and, at the same time, modify the quantities to suit our own system of building, and give our own estimate in Frazzi. This building is elaborately finished, with glazed tiles to the walls, Terrano flooring, and expensive lantern lights, and included an elaborate system of flues for the ranges, &c., which makes the comparison somewhat difficult, but I was able to arrive at the result that, as between the two systems of construction, we save 55 per cent. on the foundations, 45 per cent. on the walls, 10 per cent. on the plasterers' bill, and 5 per cent. on all the others. The ultimate result is an economy of about 25 per cent. on this particular building, the smallness of the difference being due, to a large extent, to the special items of finish above mentioned. For a plain finish, I estimate the total saving, on our system, to be about 40 per cent.

ARTHUR E. BROWN.

APPENDIX N.

REPORT UPON THE USE OF PORTABLE BUILDINGS FOR SCHOOL PURPOSES IN GERMANY AND ELSEWHERE.

(Prepared for the Board of Education in 1907.)

Description of the "Doecker" patent and other wooden buildings.

1. Temporary buildings of light construction and so made as to be easily movable are used to a considerable extent in Germany.

Such buildings are formed either of wood alone with double walls, or of a combination of wood outside and some patent material used in sheets to cover the inner walls.

Iron buildings lined with wood, such as are used in this country for temporary schools, are not found in Germany.

2. The most widely used type of portable building, which also seems to have served as a model for other forms, is that known as the "Doecker" patent of Messrs. Christoff and Unmach; but, whether made by this company or by other manufacturers, the arrangement of the buildings follows very closely the same lines—in nearly all cases they consist of two classrooms separated by a small lobby and a teachers' or cloak-room. If more rooms were required an additional block would be erected.

3. The walls of these buildings are made double, the outside being of ordinary weather boarding painted, the inner of matchboarding, or, in the better examples, of sheets of the "Doecker" patent material also painted, the interstices between the two being filled with a patent mixture of powdered cork. The "Doecker" patent material, probably a mixture of some form of asbestos and silicate, has a high degree of non-conductivity, and this, combined with the cork filling, will, it is claimed, render the buildings warm in winter and cool in summer. The roof is made double, and care is taken to ensure an ample current of air between the two parts by means of openings under the eaves. The method of construction of the

"Doecker" building, which the manufacturers claim as the great merit of the type, allows of its being taken down and re-erected on another site at a very slight cost and in a very short time, without causing any appreciable injury to the materials. This is done by making the building in sections, which are joined together by an ingenious system of hooks and eyes; these, in the completed structure, are covered by a wooden moulding and painted. This method of constructing buildings was invented to meet the need for field hospitals, and there are a large number in the possession of the Red Cross Society in Germany. These are of lighter construction than the schools, and can be put up in a few hours.

4. The foundations are similar to those for any type of building of light construction, and vary between a complete floor of concrete, upon which the building is placed, to an arrangement by which the building is placed simply upon the bare ground, either upon balks of timber or timber placed upon large stones. In all cases ample provision is made for the under-floor ventilation.

5. The roof is formed of sheets of "Doecker," "Roburite," or other patent material, the ceiling either of matchboarding or of patent material again.

6. The lighting is amply provided for by making the whole of the left hand wall, above 3 feet from the floor, windows, all of which are made to open, the lower part as casemates, the upper to fall inwards as hoppers. In the northern parts of Germany the windows are, as a rule, made double. On the opposite side there are inlets, so that through ventilation can be easily secured; extract ventilators are provided in the ceiling. The heating is provided for by stoves (slow combustion). These are always of a large size in order to avoid over-heating of the metal.

7. The other forms of portable buildings follow this pattern closely in general arrangement, differing chiefly in the method of putting together, and the absence of the patent cork filling between the walls (sawdust, however, being sometimes used), matchboarding for the inner walls, and other small details, in order to make the cost lower. Generally speaking, these buildings, which are arranged with great regard to hygienic conditions, are very satisfactory for their purpose, and were warmly spoken of by the teachers using them, who found them a welcome change from the bad class room of an old building; but they did not consider that they could be compared with a well designed class room in a new building. There seemed no very decided opinion as to the superiority of the "Doecker" building compared with the others, though in the former the details of ventilation, &c., are more carefully dealt with, and in hot weather they are probably more satisfactory. The ease with which buildings of the Doecker type can be taken down, and the rapidity of their re-erection, in which they possess an undoubted superiority, would not be points by which the teachers would be much affected.

8. The buildings are painted inside and out, and the outside paint would require re-doing every three years. In the new buildings the smell of the paint inside appeared to be rather trying during hot weather, but this would of course be only a temporary inconvenience.

9. Particular inquiry was made as regards certain specific points:—

(a) *Whether they are used in Germany for temporary or permanent purposes.*

As far as could be ascertained by inquiry from officials and others, there has never been, and is not, any idea of using such buildings for permanent school accommodation. In all the cases visited there was either a new school being built or plans being prepared or at least talked of. At the International Conference upon School Hygiene held at Nuremburg in 1904, there was a paper read, entitled "Transportable pavilions as the schools of the future," by H. Th. Meyer, with special reference to the "Doecker" system of construction. The paper, however, is really nothing but a

carefully reasoned summary of the arguments in favour of single-storied school buildings, a point which has been fully appreciated and largely acted upon in this country; in Germany and on the continent schools are nearly always on three floors.

(b) *Durability and weather resisting qualities.*

The manufacturers claim that a "Doecker" building will last 40 or 50 years. The outside of all these forms of building is constructed of weather boarding painted, and no doubt if care is taken to ensure a dry foundation and to keep the outside painted frequently (say every 3 years) they would last a considerable time.

(c) *Safety in case of fire.*

The patent "Doecker" material is fireproof, but as described above a large number of these buildings are constructed entirely of wood not treated in any way to render it fire resisting; and even when lined with "Doecker" the buildings would be only partially fireproof. When this point was raised, it was considered that the question was comparatively unimportant, on the ground that the buildings were all detached, each block containing only two classrooms, that they were on the ground floor, with windows all along one side which, opening as casements, could easily serve as emergency exits; the buildings too were used only in the daytime. In one case, where one of these buildings came within a short distance (10 feet) of another building, that end had been covered with a thick coating of plaster. If such buildings were planned upon our system of a large number of classrooms opening off a central hall or corridor, the question would be of more importance, but, on the whole, when lined with "Doecker," or other fireproof material they would be less dangerous as regards fire than an ordinary iron and wooden building.

(d) *Equability of temperature in different seasons.*

Owing, no doubt, to the wide variation in temperature against which provision has to be made, this point, *i.e.*, securing equability of temperature, has been one of the governing factors in the construction and arrangement of these buildings. The methods adopted for this purpose have been already described; they are certainly very successful, and the teachers usually drew attention to the advantages of the buildings in this respect upon their own initiative, though of course such buildings could not have the same power of resisting changes of temperature as a solid building of brick and stone.

(e) *Acoustic qualities.*

These are certainly good, the matchboarded walls no doubt contributing to this.

(f) *Hygienic qualities—(Heating, lighting, and ventilation).*

The methods upon which these are arranged have been described above, and the results are satisfactory, but vary according to the care taken to provide for them in the particular case, that is to say, practically upon the money the authorities were willing to spend.

(g) *Facility of construction and removal.*

All these buildings are made in sections so as to be easily removable, and they are intended to be moved about from place to place where wanted. Those built on the "Doecker" system are especially well adapted to this purpose, and, by means of the system of junction by hooks described above, can be taken down and re-erected without injury. The makers indeed claim that they can be moved any number of times without diminution of value.

(h) *General suitability for school purposes.*

For the purpose for which they are used, *i.e.*, the provision of temporary accommodation, they are well suited, and testimony was invariably expressed strongly in their favour by those who had had experience of teaching in them for a year or two.

APPENDIX O.

EXEMPTION OF BUILDINGS FROM THE OPERATION OF BYELAWS.

(*Memorandum put in by Mr. Kershaw.*)

1. The byelaws made by local authorities with respect to buildings and matters in connection with buildings are generally based on one of the model series of the Local Government Board. These series contain clauses exempting certain buildings from the operation of the byelaws. It is the practice to adopt the first seven paragraphs of the model exemption clause without alteration and it is seldom that any considerable alterations are made in the other paragraphs.

2. The Board's urban model exemption clause in its present form is:—

Exempted buildings.

(2) The following buildings shall be exempt from the operation of the byelaws relating to new streets and buildings:—

- (a) Any building in His Majesty's possession, or employed or intended to be employed for His Majesty's use or service:
- (b) Any county or borough lunatic asylum, and any building or part of a building belonging to the council of any county, city or borough, and used or intended to be used for the detention of any prisoners:
- (c) Any gaol, house of correction, bridewell, penitentiary, or other prison, and any building occupied or intended to be occupied by any prison officer for the use of such prison and contiguous thereto:
- (d) Any building (not being a dwelling-house) belonging to any person or body of persons authorized by virtue of any Act of Parliament to navigate on or use any river, canal, dock, harbour, or basin, or to demand any tolls or dues in respect of the navigation of such river or canal, or the use of such dock, harbour, or basin, and used or intended to be used exclusively under the provisions of such Act of Parliament for the purposes of such river, canal, dock, harbour, or basin:
- (e) Any building (not being a dwelling-house) erected or intended to be erected in connection with any mine, and used or intended to be used exclusively for the working of such mine:
- (f) Any building erected or to be erected according to plans previously approved by the Land Commissioners for England, or the Board of Agriculture, or the Board of Agriculture and Fisheries under the Improvement of Land Act, 1864, or other Act or Acts for the improvement of land:
- (g) Any building which may not be exempt by the operation of any of the preceding clauses of this byelaw, and which may be erected or may be intended to be erected in accordance with such plan

and in such manner as may be approved or directed in pursuance of any statutory provision in that behalf by one of His Majesty's Principal Secretaries of State :

- (h) Any building erected and used, or intended to be erected and used, exclusively for the purpose of a plant-house, greenhouse, or conservatory :
- (i) Any building erected and used, or intended to be erected and used, exclusively for the purpose of an orchard-house, summer-house, poultry-house, boat-house, coal-shed, garden-tool house, potting-shed, cycle-shed, or aviary which shall not exceed in extent *six hundred cubic feet*, or which if exceeding in extent *six hundred cubic feet* or if used or intended to be used as a poultry-house or aviary shall be wholly detached, and at a distance of *ten feet* at the least from any other building, not being a building exempt under paragraphs (h), (i), (j), or (k) of this byelaw :
- (j) Any building which shall not exceed in height *thirty feet*, and shall not exceed in extent *one hundred and twenty-five thousand cubic feet*, and shall not be a public building, and shall not be constructed or adapted to be used either wholly or partly for human habitation, or as a place of habitual employment for any person in any manufacture, trade, or business, and shall be distant at least *eight feet* from the nearest street, and at least *thirty feet* from the nearest building not being a building exempt under paragraphs (h), (i), (j), or (k) of this byelaw, and from the boundary of any adjoining lands or premises :
- (k) Any building which shall exceed in height *thirty feet* and shall exceed in extent *one hundred and twenty-five thousand cubic feet*, and shall not be a public building, and shall not be constructed or adapted to be used either wholly or partly for human habitation, or as a place of habitual employment for any person in any manufacture, trade, or business, and shall be distant at least *thirty feet* from the nearest street, and at least *sixty feet* from the nearest building not being a building exempt under paragraphs (h), (i), (j), or (k) of this byelaw, and from the boundary of any adjoining lands or premises :
- (l) Any building erected or intended to be erected for use solely as a temporary hospital for the reception and treatment of persons suffering from any dangerous infectious disorder.

For the purpose of this byelaw, the height of a building shall be measured from the level of the ground adjoining the walls to half the vertical height of the roof.

3. For the purposes of the byelaws the following terms used in that clause are defined :—

“Public building” means a building used or constructed or adapted to be used, either ordinarily or occasionally, as a church, chapel, or other place of public worship, or as a hospital, workhouse, college, school (not being merely a dwelling-house so used), theatre, public hall, public concert room, public ball-room, public lecture room, or public exhibition room, or as a public place of assembly for persons admitted thereto, by tickets or otherwise, or used or constructed or adapted to be used either ordinarily or occasionally, for any other public purpose :

“Building of the warehouse class” means a warehouse, factory, manufactory, brewery or distillery :

“Domestic building” means a dwelling-house or an office building, or other out-building appurtenant to a dwelling-house, whether attached thereto or not, or a shop, or any other building not being a public building, or of the warehouse class :

“Dwelling-house” means a building used or constructed or adapted to be used wholly or principally for human habitation.

4. The exemption clause in the rural model code is identical with that included in the urban model code except that paragraphs (h), (i), (j) and (k) of the latter code are replaced by the more comprehensive paragraph :—

(h) Any building which shall not be a public building or a building of the warehouse class, and shall not be constructed or adapted to be used either wholly or partly for human habitation, or as a place of habitual employment for any person in any manufacture, trade, or business, and which if intended for use as a pigsty or a cowhouse shall be detached from any dwelling-house.

5. The urban model series was first published in 1877 and the rural model in 1903.

The urban exemption clause is practically identical with that prepared in 1877 as regards the first seven paragraphs. Some relaxations have been introduced in the following paragraphs. The rural clause has not been altered since the series was first published.

6. The general objects of the urban code are the prevention of fires, the stability of buildings, and the safeguarding of public health. The rural code is confined almost entirely to the last of these objects. The reason for this limitation is the desire not to impose in rural areas requirements which may unduly hamper the provision of house accommodation.

7. The following notes show the reasons which have led to the inclusion of the various paragraphs in the model codes :—

Paragraph (a).—This paragraph was based on a clause in the Metropolis (Buildings and Management) Bill, 1874. The question was raised whether the specific exemption of these buildings from the byelaws was really necessary. The Board took the view that exemption from the statute could only be derived from the maxim that the Crown is not bound by statute unless expressly mentioned. It was observed that Royal palaces are specially exempted in section 6 of the Metropolitan Building Act, 1855 (18 & 19 Vict. cap. 122), and that section 327 of the Public Health Act, 1875 (38 & 39 Vict. cap. 55) enacts that nothing in that Act shall be construed to authorise any interference by a local authority with any lands or other property vested in the Lord High Admiral or in the Secretary of State for War. In view of these express references the Board were inclined to consider that an exemption clause for Crown property was desirable.

Paragraphs (b) and (c).—There are no statutory provisions exempting the classes of buildings dealt with in these paragraphs from control by byelaws made by local authorities. In view, however, of the conditions under which lunatic asylums are erected pursuant to the provisions of the Lunacy Acts, and, in the case of prison buildings, of the control exercised by the Secretary of State, the Board considered that the regulation of the construction of such buildings by a local authority's byelaws was unnecessary.

Paragraphs (d) and (e).—Provisions are contained in the Public Health Act, 1875, for the protection of rivers, harbours, docks, canals, and mines. The exemption in the paragraphs does not extend to any dwelling-house, and having regard to the exceptional nature of other buildings constructed in connection with the undertakings referred to, the Board did not consider it necessary in the interests of the public health to bring such buildings within the scope of byelaws.

Paragraphs (f) and (g).—These paragraphs were included at the desire of the Inclosure Commissioners and the Home Office respectively, and in view of the control exercised by those Departments of the State.

Paragraphs (h), (i), (j) and (k).—In view of the use of these buildings it is not considered necessary that the byelaws should apply to them. The prevention of the spread of fire to other buildings is intended to be secured by the limitations as to size and the comparative isolation required. As the prevention of fires is not one of the objects of the

rural code, no such limitation is imposed or isolation required in the case of the buildings included in the corresponding paragraph (h) in that series.

Paragraph (l).—The temporary nature of the buildings mentioned in this paragraph and the urgency frequently involved in their erection render it undesirable to insist on the solidity of construction or submission of plans, &c., as in the case of more permanent buildings.

8. The main principles which dictate the exemption of buildings from the operation of byelaws are:—

- (1) That the byelaws are framed with a view to the regulation of buildings of the kinds most commonly erected for the purposes of human habitation or as a place for the employment of workers or to which persons resort, and such byelaws if applied literally might operate unreasonably as regards buildings of a special or exceptional character.
- (2) That the objects which the byelaws are intended to secure will be attained no less certainly by other means (such as the requirements of a Government Department or other competent and responsible body).

9. Since the passing of the Education Act, 1902, the Board have had proposals before them for the exemption from building byelaws of school buildings proposed to be erected by the local education authority. In most of these cases the buildings proposed were of a temporary character, and the methods of construction were not such as would in certain respects comply with the byelaws in force in the locality. The Board have not adopted any general form of exemption for school buildings, but in view of the fact that the plans of the buildings are in every case required to be approved by the Board of Education, they have in a number of cases approved of a clause exempting the buildings from the operation of the byelaws either generally or in regard to particular matters. A copy of a byelaw giving a general exemption to existing and future school buildings in respect of walls is appended:—

“Any building erected or to be erected according to plans previously approved by the Board of Education shall be exempted from the operation of the byelaws numbered ten to thirty* in the byelaws with respect to new streets and buildings which were made by the mayor, aldermen and burgesses of the said County Borough of St. Helens acting by the Council on the eighth day of November, 1893, and were confirmed by the Local Government Board on the eighteenth day of November, 1893.”

10. The following byelaw provided for the exemption from all byelaws of temporary school buildings erected or intended to be erected:—

“Any temporary building erected or intended to be erected by the Urban District Council of Bilston in accordance with plans previously approved by the Board of Education shall be exempt from the operation of the byelaws with respect to new buildings which were made by the Urban District Council of Bilston on the twenty-fifth day of July, 1900, and were confirmed by the Local Government Board on the seventeenth day of November, 1900.”

APPENDIX P.

TABLES REFERRED TO IN PARAGRAPH 64 OF THE REPORT.

Table I. shows in column (a) the annual loan charges, and in column (b) the total loan charges, payable in respect of a loan of 1,000*l.* for a period of 50 years, distinguishing between the amounts payable if the money is borrowed at (1) 3½ per cent. interest or (2) 3¼ per cent. interest.

* Relating to walls.

Table II. shows in column (c) the annual loan charges, and in column (d) the total loan charges, payable in respect of loans ranging in amount from 900*l.* to 700*l.* The difference between each of these capital sums and the standard sum of 1,000*l.* used in Table I. represents the saving which, it is assumed, might be made by cheaper methods of construction such as are contemplated in par. 63 (iv) of the Report.

It is to be observed that the rate of interest charged by the Public Works Loan Commissioners is $3\frac{1}{2}$ per cent. if the period of repayment is 30 years, but $3\frac{3}{4}$ per cent. if the period of repayment is 50 years. In Table II., therefore, interest is calculated at $3\frac{1}{2}$ per cent. only.

TABLE I.—ORDINARY CONSTRUCTION : 50 YEARS LOAN.

Loan.	(a) Annual Loan Charges.	(b) Total Loan Charges.
£ 1,000	(1) If borrowed from a lender other than the Public Works Loan Commissioners at $3\frac{1}{2}$ % interest } £42 12s. 8d. (2) If borrowed from the Public Works Loan Commissioners at $3\frac{3}{4}$ % interest } £44 11s. 6d.	£ (1) 2,132 (2) 2,229

TABLE II.—SPECIAL CONSTRUCTION : 30 YEARS LOAN.

Loan	Saving % on Table I.	(c) Annual Loan Charges.	Increase (+) or Saving (-) between (c).			(d) Total Loan Charges.	Saving between (d) and	
			(a) (1).	(a) (2).			(b) (1).	(b) (2).
£		£ s. d.	£ s. d.	£ s. d.	£	£	£	
900	10	48 18 8	+6 6 0	+4 7 2	1,468	664	761	
850	15	46 4 4	+3 11 8	+1 12 10	1,386	746	843	
800	20	43 9 11	+0 17 3	-1 1 7	1,305	827	924	
784	$21\frac{3}{5}$	42 12 8	Nil	-1 18 10	1,279	853	950	
750	25	40 15 7	-1 17 1	-3 15 11	1,223	909	1,006	
700	30	38 1 2	-4 11 6	-6 10 4	1,142	990	1,087	

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COMMITTEE ON THE COST OF SCHOOL BUILDINGS.

REPORT

AND

ABSTRACTS OF EVIDENCE

TAKEN BEFORE THE

DEPARTMENTAL COMMITTEE

ON THE

COST OF SCHOOL BUILDINGS.

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